

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY

IN MISSOURI, FISCAL YEAR 1987

Compiled by Brenda J. Smith and Katherine L. Jenkins

---

U.S. GEOLOGICAL SURVEY

Open-File Report 88-99



Rolla, Missouri

1988

DEPARTMENT OF THE INTERIOR  
DONALD PAUL HODEL, Secretary  
U.S. GEOLOGICAL SURVEY  
Dallas L. Peck, Director

---

For additional information  
write to:

District Chief  
U.S. Geological Survey  
1400 Independence Road  
Mail Stop 200  
Rolla, Missouri 65401

Copies of this report can  
be purchased from:

U.S. Geological Survey  
Books and Open-File Reports  
Federal Center, Bldg. 810  
Box 25425  
Denver, Colorado 80225

## Message from the District Chief

This report describes the U.S. Geological Survey, Water Resources Division, organization in Missouri, our primary sources of funds, and hydrologic concerns. The agency first began its operation in Missouri in 1921 and since that time has experienced many changes in the day-to-day operation, but it still maintains the basic mission of providing hydrologic information and helping appraise the Nation's water resources. The work continues to be challenging, and the agency's continuing success largely is because of the cooperation of local, State, and other Federal agencies.

Missouri has an abundance of water, which has played a primary role in the settlement and development of the State. At present, however, there is an increasing concern for the wise management of the State's water, particularly as the demands on the water resources increase. Erosion, hazardous and toxic wastes, pesticides, abandoned coal-mine areas, and other issues affect the State's water resources. These issues require accurate hydrologic data and accurate scientific interpretation of that data.

To address these water issues, the Missouri District continues to initiate relevant projects. An expanded Phase II effort has begun for the Weldon Spring low-level radioactive waste sites, with work principally evaluating the possible movement of the waste in the hydrologic system of the area. The occurrence of pesticides in ground water is being studied by the areal sampling of about 100 wells in the Mississippi Alluvial Plain; additional work is planned for northern Missouri. Acidity in surface and ground water caused by abandoned coal mines has been studied at several locations and the studies have significantly aided cleanup operations. A current study in the Old Lead Belt region, in the southern part of the State, will evaluate the source and transport of tailings and associated metals in the surface-drainage systems. Because of concern for diminishing trout populations in Lake Taneycomo, current and historical sediment deposition rates are being determined using conventional- and isotope-dating techniques. A generalized multilayered ground-water model is being developed for the rapidly expanding Springfield area to help plan future ground-water pumpage. Flood-risk analysis is significant, and work continues on flood-estimation techniques for flow volumes and peaks at ungaged locations in the State.

The Missouri District continues to make our products available to the public in a timely, complete, and accurate manner so that water managers can use this information to understand, plan, and effectively use our water resources. Our office continues to strive to maintain a cooperative water program that is relevant to current critical State, local, and national needs. I look forward to our continued efforts to cooperatively solve the vital water issues confronting our State.



Daniel P. Bauer  
District Chief  
U.S. Geological Survey  
Water Resources Division  
1400 Independence Road  
Mail Stop 200  
Rolla, Missouri 65401

## ORIGIN AND MISSION OF THE U.S. GEOLOGICAL SURVEY

The U.S. Geological Survey was established by an act of Congress on March 3, 1879, to provide a permanent Federal agency to conduct the systematic and scientific "classification of the public lands, and examination of the geological structure, mineral resources, and products of national domain." An integral part of that original mission includes publishing and disseminating the earth-science information needed to understand, to plan the use of, and to manage the Nation's energy, land, mineral, and water resources.

Since 1879, the research and fact-finding role of the U.S. Geological Survey has grown and been modified to meet the changing needs of the Nation it serves. As part of that evolution, the U.S. Geological Survey has become the Federal Government's largest earth-science research agency, the Nation's largest civilian mapmaking agency, the primary source of data on the Nation's surface- and ground-water resources, and the employer of the largest number of professional earth scientists. Today's programs serve a diversity of needs and users. Programs include:

- Conducting detailed assessments of the energy and mineral potential of the Nation's land and offshore areas.
- Investigating and issuing warnings of earthquakes, volcanic eruptions, landslides, and other geologic and hydrologic hazards.
- Conducting research on the geologic structure of the Nation.
- Studying the geologic features, structure, processes, and history of the other planets of our solar system.
- Conducting topographic surveys of the Nation and preparing topographic and thematic maps and related cartographic products.
- Developing and producing digital cartographic data bases and products.
- Collecting data on a routine basis to determine the quantity, quality, and use of surface and ground water.
- Conducting water-resource appraisals in order to describe the consequences of alternative plans for developing land and water resources.
- Conducting research in hydraulics and hydrology, and coordinating all Federal water-data acquisition.
- Using remotely sensed data to develop new cartographic, geologic, and hydrologic research techniques for natural resources planning and management.
- Providing earth-science information through an extensive publications program and a network of public access points.

Along with its continuing commitment to meet the growing and changing earth-science needs of the Nation, the U.S. Geological Survey remains dedicated to its original mission to collect, analyze, interpret, publish, and disseminate information about the natural resources of the Nation--providing "Earth Science in the public service."

## MISSION AND PROGRAM OF THE WATER RESOURCES DIVISION

The mission of the Water Resources Division is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people of the United States.

This is accomplished, in large part, through cooperation with other Federal and non-Federal agencies, by:

- ° Collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources.
- ° Conducting analytical and interpretive water-resource appraisals describing the occurrence, availability, and the physical, chemical, and biological characteristics of surface and ground water.
- ° Disseminating the water data and the results of these investigations and research through reports, maps, computerized information services, and other forms of public releases.
- ° Coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and ground water.
- ° Providing scientific and technical assistance in hydrologic fields to other Federal, State, and local agencies, to licensees of the Federal Energy Regulatory Commission, and to international agencies on behalf of the Department of State.

## CONVERSION FACTORS

For readers who prefer to use metric (SI) units, conversion factors for terms used in this report are listed below:

<u>Multiply</u>	<u>By</u>	<u>To obtain</u>
inch	25.40	millimeter
mile	1.609	kilometer
square mile	2.590	square kilometer
cubic yard	0.7646	cubic meter
acre	0.4047	hectare
gallon	3.785	liter

# CONTENTS

	Page
Abstract.....	1
Missouri district.....	1
Operating sections.....	1
Support units.....	4
Cooperation and program funding.....	4
Water conditions.....	6
National hydrologic-data networks and programs.....	10
Hydrologic data-collection programs.....	12
Collection of surface-water data, MO 00-001.....	19
Collection of ground-water data, MO 00-002.....	21
Collection of quality-water data, MO 00-003.....	22
Collection of sediment data, MO 00-004.....	24
Water-use data-collection and reporting program for Missouri, MO 00-007.....	25
Areal hydrologic investigations.....	27
Hydrogeology of the Paleozoic aquifers in southern Missouri, MO 81-047.....	28
Hydrogeology of southeastern Missouri, MO 82-052.....	31
Potential effects of hazardous wastes on the hydrologic system in the Weldon Spring area, St. Charles County, Missouri, MO 84-059.....	33
Flood characteristics and flood-hazard delineation in the Ozark National Scenic Riverways, southeastern Missouri, MO 84-061.....	35
Hydrology of abandoned strip mines and effects of reclamation at the Power Mine in western Missouri, MO 85-062.....	37
Hydrology of the Tiger Mine area, Bates County, Missouri, MO 85-062A.....	39
Water-quality characterization of the Spring River basin, southwestern Missouri, MO 85-065.....	41

# CONTENTS--Continued

Page

## Areal hydrologic investigations--continued

Identification of hydrologic information describing impacts of pre-August 3, 1977, non-coal mining on water resources of Missouri, MO 85-066.....	43
Techniques for estimating flood hydrographs on ungaged streams for risk analysis, MO 85-067.....	45
Effects of special-area land treatment on sediment and nutrient transport in the Higginsville Reservoir basin, Missouri, MO 85-068.....	47
The occurrence of pesticides in ground water, streams, and streambed sediment in the Southeast Lowlands of Missouri, MO 86-069.....	49
Ground-water resources of the Ozark aquifer near Springfield, Missouri, MO 87-070.....	50
Extent and magnitude of contamination of the water resources in the vicinity of the Weldon Spring radioactive waste-disposal sites, St. Charles County, Missouri, MO 87-071.....	51
Effects of lead and zinc mining on the quality of surface water and recent alluvium in the Old Lead Belt of southern Missouri, MO 87-072.....	52
Mine drainage and subsidence problems from abandoned underground coal mines at Huntsville, Missouri, MO 87-073....	53
Sources of Water Resources Division publications and information....	54
References cited.....	56
Selected references for Missouri.....	57



## ILLUSTRATIONS

	Page
Figure 1. Map showing location of offices of the U.S. Geological Survey in Missouri.....	2
2. Chart showing Missouri District organization and office addresses and telephone numbers.....	3
3. Diagram showing distribution of funding for water-resources programs of the U.S. Geological Survey in Missouri, fiscal year 1987.....	5
Figures 4.-8. Maps showing:	
4. Mean annual precipitation.....	7
5. Average discharge of the principal rivers.....	7
6. Physiographic divisions and major drainage basins....	8
7. Availability of ground water.....	9
8. Flood-prone area maps completed in Missouri.....	11

## TABLE

	Page
Table 1. Daily discharge and surface-water quality stations in operation during fiscal year 1987.....	13

# WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY

IN MISSOURI, FISCAL YEAR 1987

Compiled By

Brenda J. Smith and Katherine L. Jenkins

## ABSTRACT

Water-resources activities of the U.S. Geological Survey in Missouri consist of collecting hydrologic data and making interpretive studies. Hydrologic studies in Missouri are made through three basic types of projects: (1) hydrologic data-collection programs, (2) local or areal hydrologic investigations, and (3) statewide or regional studies. These projects are funded through cooperative joint-funding agreements with State and local agencies, transfer of funds from other Federal agencies, and direct Federal funds. The data and the results of the investigations are published or released by either the U.S. Geological Survey or by cooperating agencies. This report describes the hydrologic data-collection programs and local or areal hydrologic investigations in Missouri for fiscal year 1987 and provides a list of selected water-resources references for Missouri.

## MISSOURI DISTRICT

A District office of the U.S. Geological Survey was established in Rolla, Missouri, during 1921, when a cooperative program was begun with the Missouri Bureau of Geology and Mines (now the Missouri Department of Natural Resources, Division of Geology and Land Survey). The Missouri District, with field headquarters in Rolla, Independence, and Olivette, and a project office in Independence (fig. 1), investigates the occurrence, quantity, quality, distribution, and movement of surface and ground water in Missouri.

Hydrologic data-collection programs and interpretive studies in Missouri are conducted by two operating sections and three support units (fig. 2). The two operating sections are responsible for the implementation and execution of District projects assigned to project chiefs.

### Operating Sections

The Hydrologic Surveillance and Analysis Section designs, constructs, operates, and maintains all hydrologic-data networks in the State. The Section manages the collection and analysis of the hydrologic data for the State network, processes and reviews data for publication, prepares water-resources data for the annual water-data report, and provides quality control of results for field and office methods.

The Hydrologic Studies Section plans, executes, and reports on water-resources projects, including multidiscipline appraisal studies, and conducts hydrologic and hydraulic investigations. These investigations include ground-water hydraulics and mathematical modeling of aquifer systems, environmental concerns, hydraulics affected by manmade structures, magnitude and frequency of floods and droughts, hydrology of urban areas, analysis of the effect and assessment of hazardous waste and historical and ongoing mineral mining on the hydrologic system, and traveltime and dispersion studies.

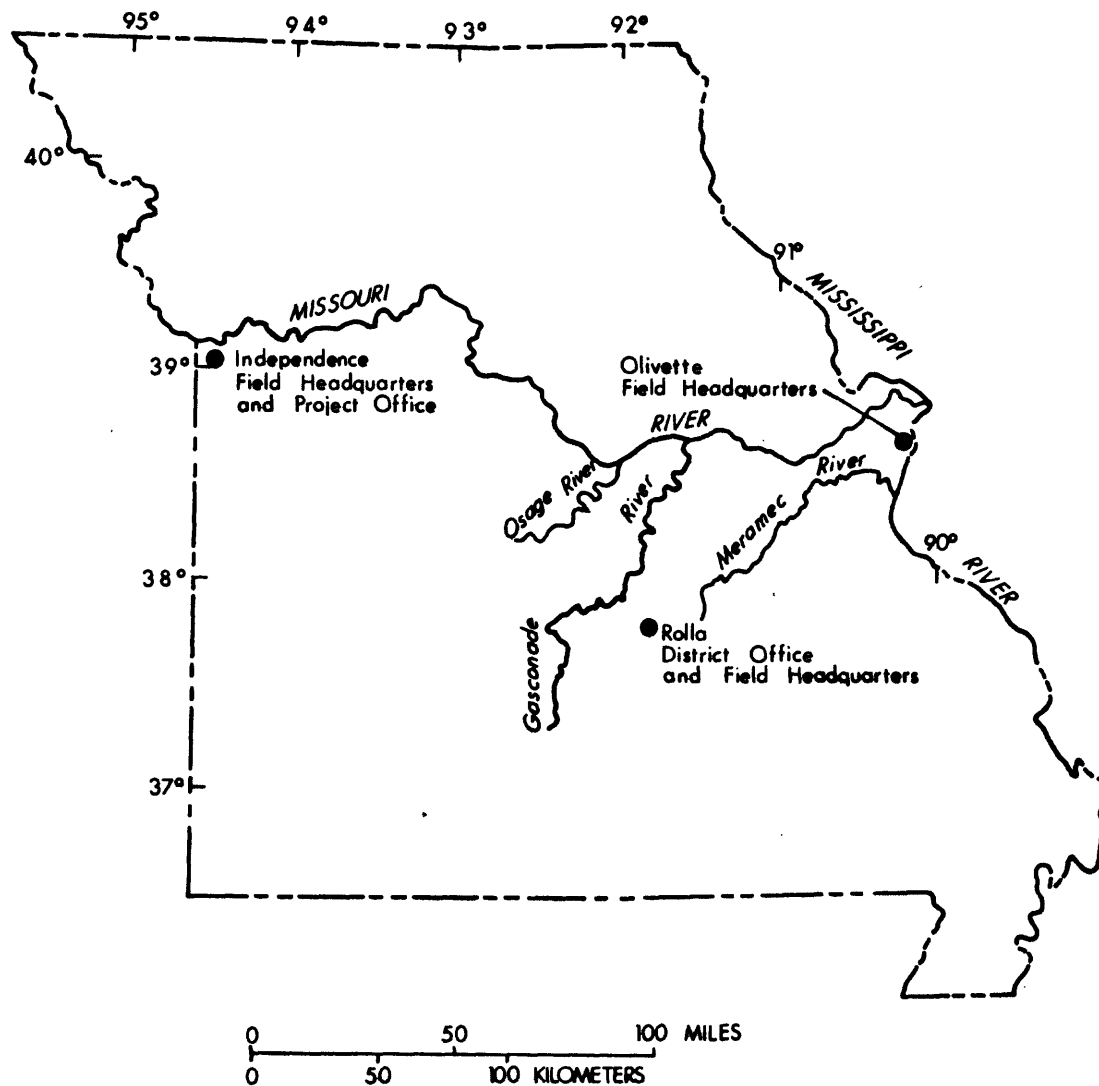
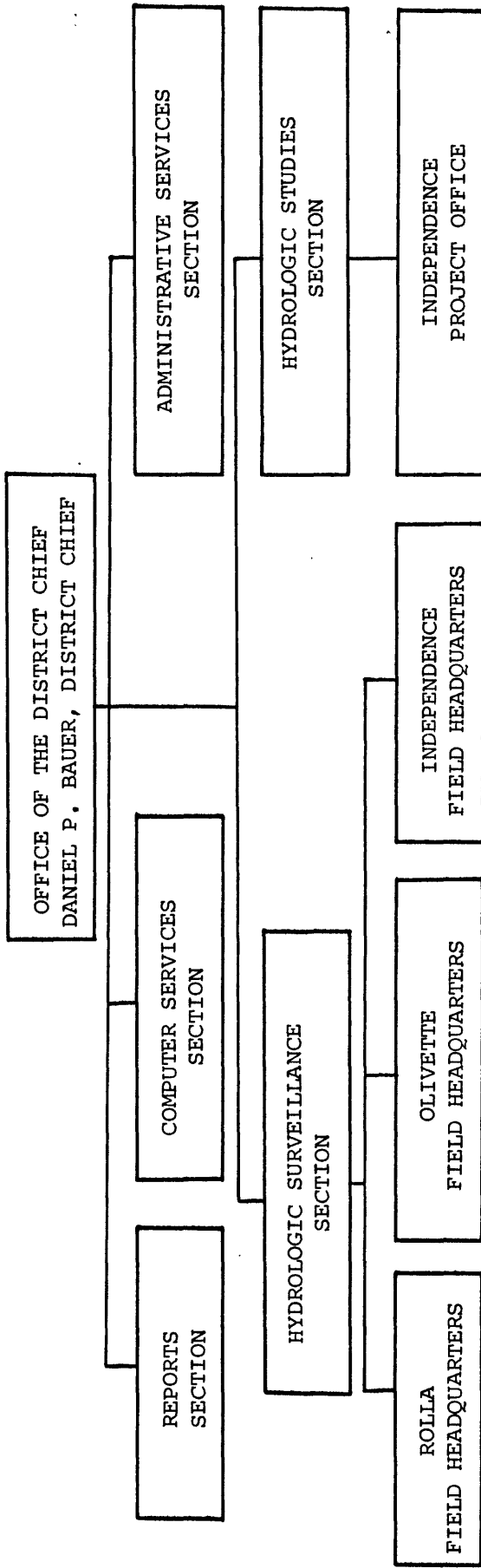


Figure 1.--Location of offices of the U.S. Geological Survey in Missouri.



<p>Rolla Field Headquarters H.L. Reed, SupvHydrolTech (314) 341-0843 1400 Independence Road Mail Stop 200 Rolla, MO 65401</p>	<p>DISTRICT OFFICE (314) 341-0824 1400 Independence Road Mail Stop 200 Rolla, MO 65401</p>	<p>Olivette Field Headquarters D.O. Hatten, SupvHydrolTech (314) 567-7077 Dielman Industrial Center 9351 Dielman Industrial Drive Olivette, MO 63132</p>
<p>Independence Field Headquarters T.J. Perkins, Lead HydrolTech (816) 254-7272 Room 223, Federal Building 301 West Lexington Independence, MO 64050</p>		<p>Independence Project Office D.W. Blevins, Hydrologist (816) 254-5824 Room 219, Federal Building 301 West Lexington Independence, MO 64050</p>

Figure 2.--Missouri District organization and office addresses and telephone numbers.

## Support Units

The Reports Section maintains progress records of technical and hydrologic-data reports; reviews project annotated outlines; and edits, types, assembles, verifies, and prepares manuscripts and illustrations for publication. The Section advises and updates District personnel on current report-writing procedures.

The Computer Services Section manages and maintains the District's computer system, and coordinates processing, storage, and retrieval of data for the District and National computer files. The Section helps design, implement, and maintain the computer program software necessary for District operation.

The Administrative Services Section provides administrative support for the District, including programming, budgeting, accounting, management of personnel, property inventory, travel records, vehicle management, and related services.

## COOPERATION AND PROGRAM FUNDING

The Missouri District and agencies of the State of Missouri have had cooperative agreements for the systematic collection of streamflow records since 1921. About 90 percent of the hydrologic data collected by the U.S. Geological Survey in Missouri is in cooperation with local, State, or other Federal agencies.

Collection of surface-water data was begun at a few selected sites during 1903; collection of ground-water data in cooperation with the Missouri Division of Geology and Land Survey was begun during 1963; and collection of water-quality data was begun during 1962 in cooperation with the Missouri Water Pollution Control Board (now a part of the Missouri Division of Environmental Quality). Surface-water data primarily are collected cooperatively with other Federal agencies, whereas the ground-water and water-quality data primarily are collected in cooperation with the Missouri Department of Natural Resources. These types of data are needed for the continuing determination and evaluation of the quantity, quality, and use of Missouri's water resources.

Moneys for program operation of the U.S. Geological Survey in Missouri come from joint-funding agreements with local and State agencies, transfer of funds from other Federal agencies, and direct Federal funds. Distribution of funding for program operation during fiscal year 1987 is shown in figure 3.

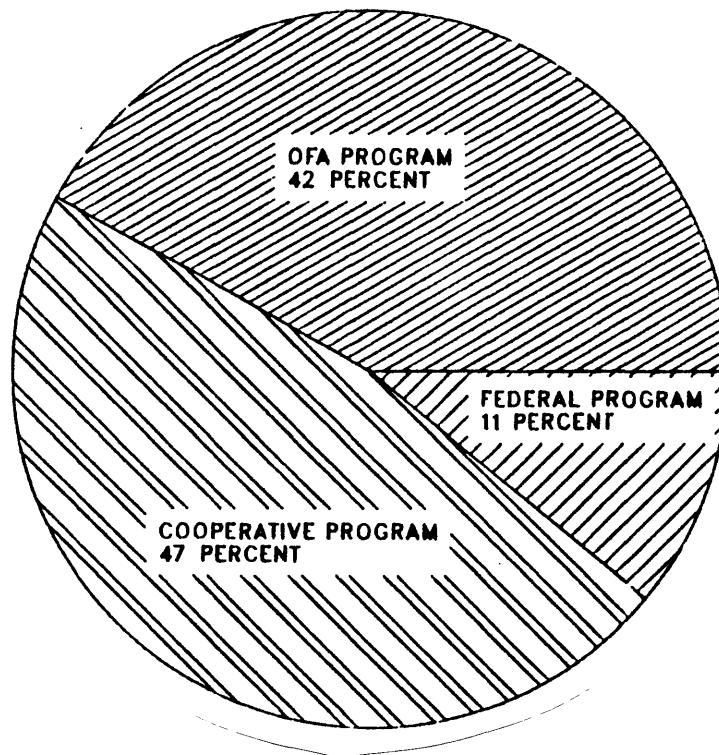


Figure 3.--Distribution of funding for water-resources programs of the U.S. Geological Survey in Missouri, fiscal year 1987.

Agencies cooperating with the U.S. Geological Survey in Missouri during the 1987 fiscal year are:

Local and State agencies

City Utilities of Springfield  
 Little River Drainage District  
 Missouri Department of Conservation  
 Missouri Department of Natural Resources  
     Division of Environmental Quality  
         Land Reclamation Commission  
         Water Pollution Control Program  
     Division of Geology and Land Survey  
 Missouri Division of Health  
 Missouri Highway and Transportation Commission  
 Union Electric Company of Missouri

Federal agencies

National Park Service  
 U.S. Army, Corps of Engineers  
 U.S. Department of Commerce, National Weather Service  
 U.S. Department of Energy  
 U.S. Environmental Protection Agency

## WATER CONDITIONS

Sufficient water for present demands is available in many parts of Missouri during most years. Annual precipitation ranges from 34 inches in the northwest to 46 inches in the southeast, according to the National Weather Service (fig. 4), but in some years precipitation has been as much as 15 inches less than normal.

Surface-water supplies generally are adequate for most uses (fig. 5). However, variation in availability occurs within and among the State's three major physiographic regions: the Western Interior Plains, the Ozark Plateaus Province, and the Mississippi Alluvial Plain (fig. 6). Some small communities in the Plains region, for example, can have water-supply shortages during droughts because many of the public-water supply districts serve large areas and cannot meet increased demands during extreme low-flow periods. Ozark streams generally have the best-sustained low flows because of the contribution of ground water from extensive solution cavities in the carbonate aquifers; however, in certain stream reaches water can be lost to these aquifers. Low flows in the Mississippi Alluvial Plain region are second in magnitude to those of the Ozarks and are sustained by ground-water contributions from the extensive alluvial deposits.

More communities depend on ground water than on surface water, but larger quantities of surface water are withdrawn because most of Missouri's large cities have surface-water supplies. The southeastern two-thirds of the State is underlain by freshwater aquifers (Harris, 1979). Large quantities of saline ground water are available in the northwestern one-third of Missouri (fig. 7). However, without desalination, this water is unsuitable for most purposes. In local areas of the State, the increased use of ground water for farmland irrigation has lowered ground-water levels.

Generally, water quality in Missouri streams and aquifers is adequate for most uses (Missouri Division of Geology and Land Survey, 1967). However, water quality concerns in Missouri include stream erosion that is among the largest in the United States; carbonate rocks in the Ozarks region that contain solution-enlarged cracks and crevices allowing contaminants, such as sewage-lagoon effluent, to directly enter the shallow ground-water system; dioxin that is present in the soil and streambed sediment in several stream basins and may move through the hydrologic system in association with sediment particles; and many obsolete sewage-treatment plants in the State that adversely affect the water quality of streams.

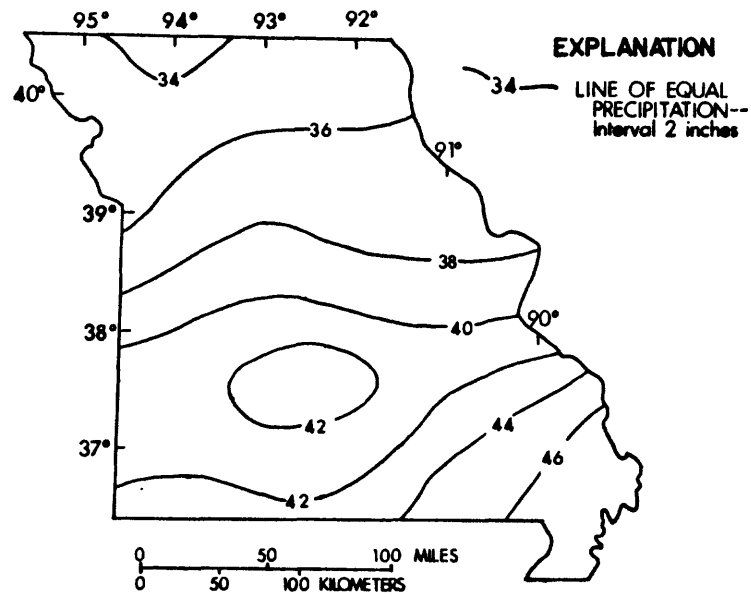


Figure 4.--Mean annual precipitation.

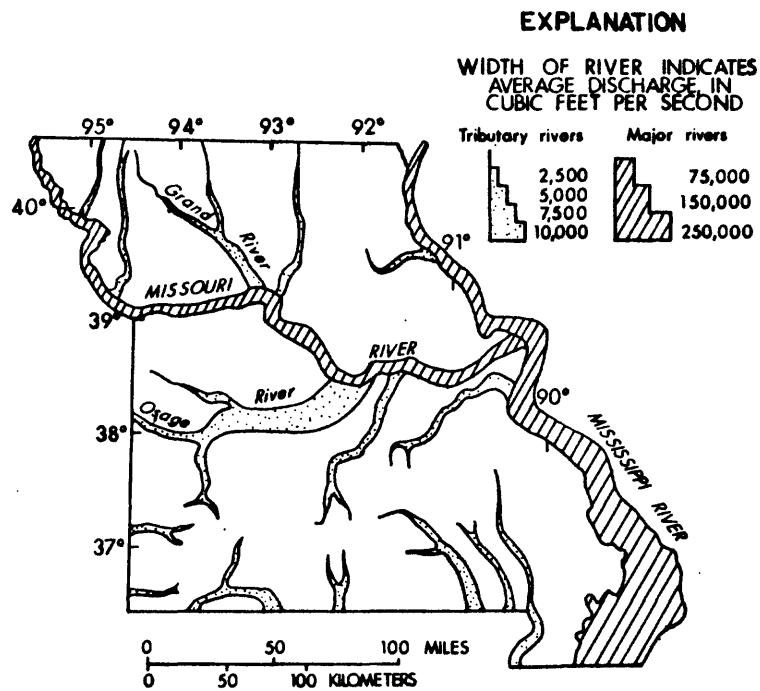


Figure 5.--Average discharge of the principal rivers.



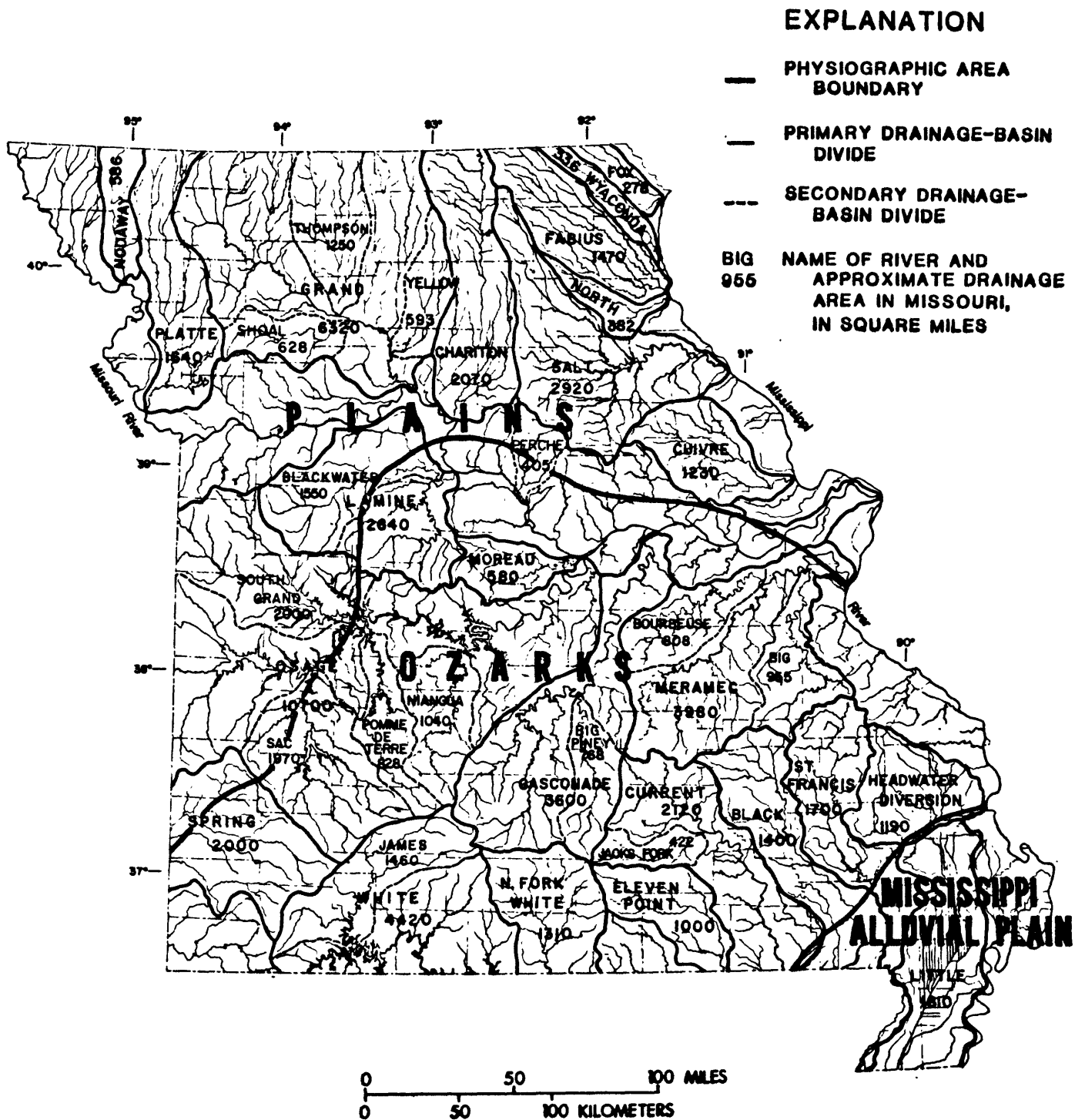


Figure 6.--Physiographic divisions and major drainage basins.

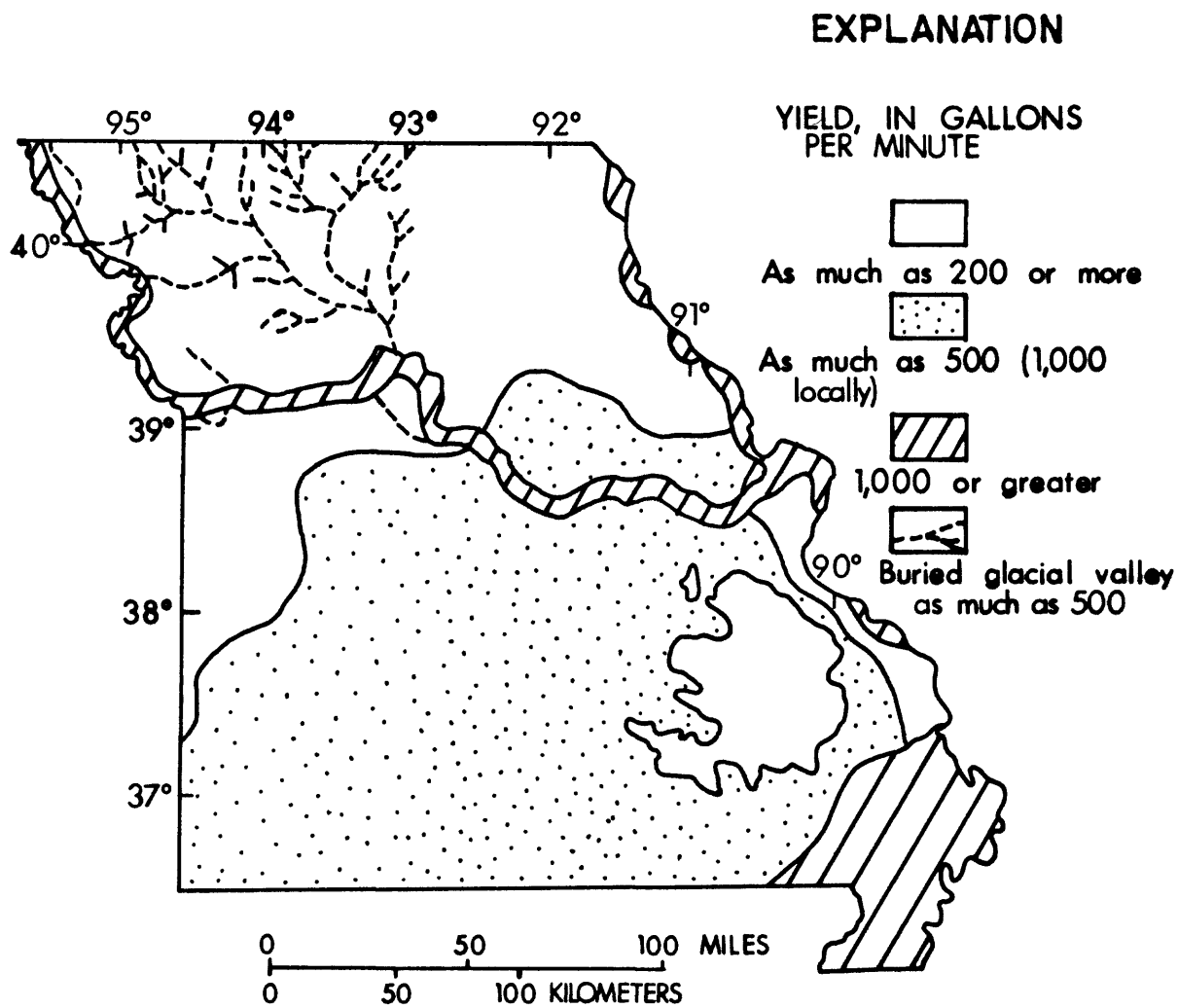


Figure 7.--Availability of ground water.

## NATIONAL HYDROLOGIC-DATA NETWORKS AND PROGRAMS

A significant quantity of stream water-quality data is collected in Missouri as part of the National Stream Quality Accounting Network (NASQAN). NASQAN is a data-collecting effort for obtaining consistent regional and nationwide overviews of the quality of streams. The primary objectives of the network are to: (1) Account for the quantity and quality of water moving within and from major river basins in the United States; (2) depict areal variability; (3) detect changes in stream quality; and (4) provide data for future assessments of changes in stream quality. Fourteen NASQAN stations are included in the Missouri District's hydrologic data-collection program.

The National Water-Use Information Program of the U.S. Geological Survey is a Federal-State cooperative program designed to collect, store, and disseminate water-use information both nationally and locally. The program was begun during 1978 to meet the need for a single source of uniform information on water use. The water-use information from this program complements long-term U.S. Geological Survey data on the availability and quality of the Nation's water resources. Information on the National Water-Use Information Program and its data bases can be obtained from:

Program Manager  
National Water-Use Information Program  
U.S. Geological Survey  
440 National Center  
Reston, Virginia 22092

As part of the U.S. Geological Survey's program of releasing water data to the public, a large-scale computerized system is used for the storage and retrieval of water data. At the present (1987), all primary U.S. Geological Survey water-resources data are maintained on the National Water Data Storage and Retrieval System (WATSTORE) at the central computer facilities in Reston, Virginia. In addition, much of these data is stored and available on District minicomputer files using the Distributed Information System (DIS). The DIS configuration provides easier dissemination and access of data that pertain to a given state. These data are available for water planning and management in machine-readable form, computer-printed tables or graphs, statistical tabulations, and digital plots. Information about the availability of specific types of data, the acquisition of data or products, and user charges can be obtained from the District office in Rolla.

A Master Water Data Index (MWDI) was developed by the Office of Water Data Coordination (OWDC) and is managed by the National Water Data Exchange (NAWDEX) Program Office to assist users of water data to identify, locate, and acquire needed data. The U.S. Geological Survey through OWDC coordinates the water-data-acquisition activities of the U.S. Geological Survey and other Federal agencies. This information is made available to all users of water data by means of a national network of assistance centers. In Missouri, NAWDEX services can be obtained from the District Chief, Rolla, Missouri.

The U.S. Geological Survey outlines flood-prone areas on topographic maps as part of a nationwide Federal program for managing flood losses. Studies of the frequency and extent of flooding in Missouri have resulted in delineation of the 100-year flood boundary on selected topographic quadrangle maps (fig. 8). These maps are available on request from the Missouri District office in Rolla.

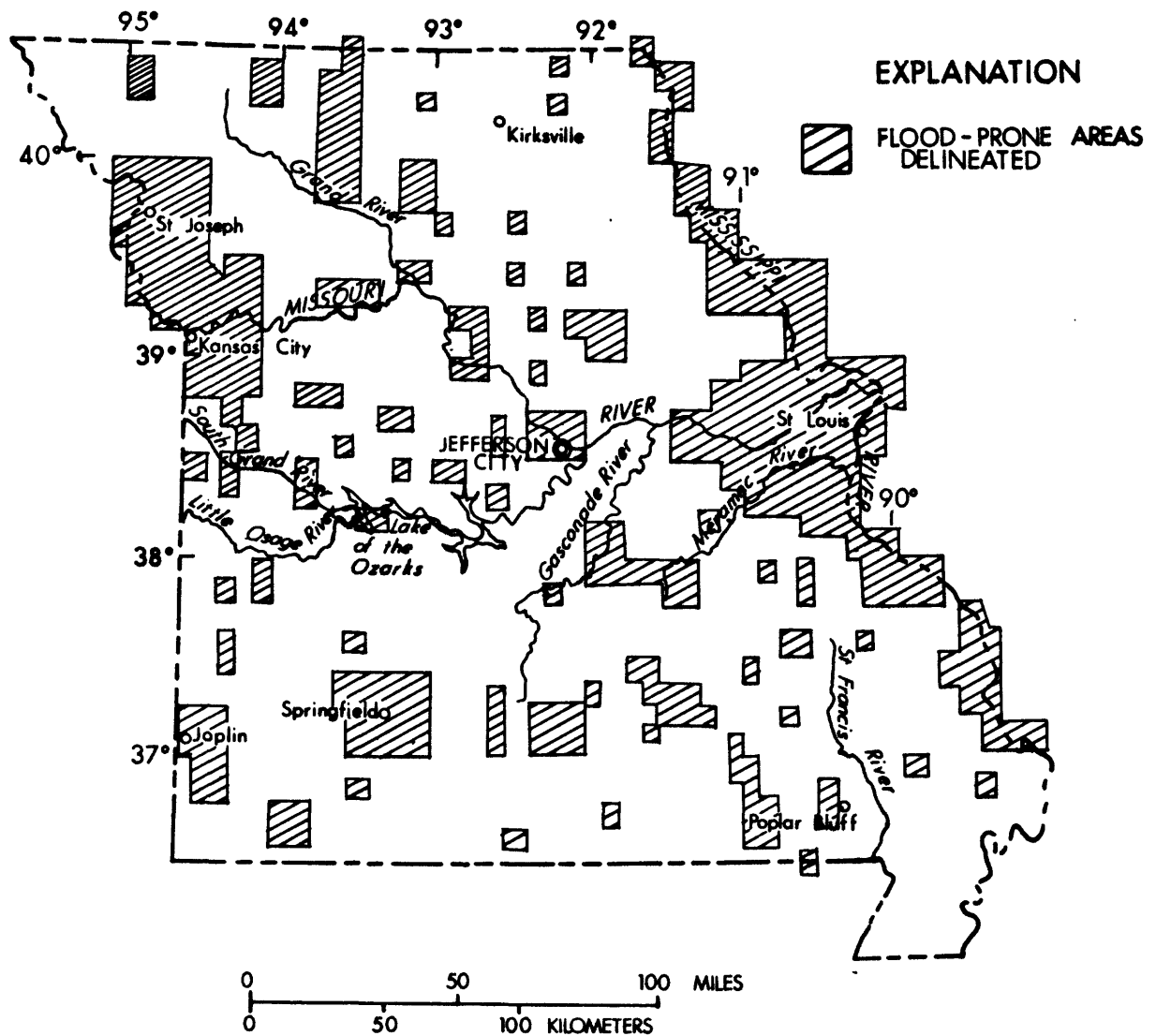


Figure 8.--Flood-prone area maps completed in Missouri.

## HYDROLOGIC DATA-COLLECTION PROGRAMS

Hydrologic data-collection stations are maintained by the U.S. Geological Survey throughout Missouri to obtain records of stream discharge or stage, lake and reservoir storage, spring discharge, ground-water levels, and the quality of surface and ground water. Major drainage basins in Missouri and approximate areas in square miles are shown in figure 6. Daily discharge and surface-water quality data-collection stations in operation during fiscal year 1987 are listed in downstream order in table 1, which also includes the cooperating agency and type of data collected. In addition to these stations, the Missouri District, in cooperation with the Missouri Division of Geology and Land Survey, collects data from 137 low-flow partial-record sites, 24 peak-flow partial-record sites, and about 200 observation wells throughout the State.

Hydrologic data collected in Missouri as part of the data-collection network are published annually in a report entitled "Water Resources Data, Missouri, Water Year 19\_\_" (the water year is from October 1 of each year to September 30 of the following year). These data represent the majority of water resources data collected in Missouri in cooperation with local, State, and other Federal agencies. Reports for each year are released the following year. Water-data reports are available for inspection at the U.S. Geological Survey in Rolla, Missouri, or may be purchased from the U.S. Department of Commerce, National Technical Information Service, Springfield, Virginia 22161.

Table 1.--Daily discharge and surface-water quality stations in operation during fiscal year 1987

Station number	Station name	Cooperation <sup>1</sup>	Type of data <sup>1</sup>
05490600	Des Moines River at St. Francisville	USGS, CE RI	CST
05495000	Fox River at Wayland	CE RI	D
05496000	Wyaconda River above Canton	CE RI	D
05497000	North Fabius River at Monticello	CE RI	D
05498000	Middle Fabius River near Monticello	CE RI	D
05500000	South Fabius River near Taylor	CE RI, DEQ	DC
05501000	North River at Palmyra	CE RI	D
05501600	Mississippi River at Hannibal	DEQ	C
05502000	Bear Creek at Hannibal	CE RI	D
05502300	North Fork Salt River at Hagers Grove	CE STL	D
05503500	North Fork Salt River near Hunnewell	CE STL	DST
05503800	Crooked Creek near Paris	CE STL	D
05505000	South Fork Salt River at Santa Fe	CE STL	D
05506500	Middle Fork Salt River at Paris	CE STL	DST
05506800	Elk Fork Salt River near Madison	CE STL	D
05507600	Lick Creek at Perry	CE STL	D
05507800	Salt River near Center	CE STL	D
05508000	Salt River near New London	CE STL	DST
05508800	Spencer Creek near Frankford	CE STL	D
05509300	Salt River near Ashburn	CE STL	LS
05514500	Cuivre River near Troy	CE STL, DEQ, USGS	CD
05587500	Mississippi River at Alton, Ill.	CE STL, USGS	ST
05587550	Mississippi River below Alton, Ill.	USGS	C
06813000	Tarkio River at Fairfax	DGLS	D
06817700	Nodaway River near Graham	CE KC	D
06817800	Nodaway River near Oregon	DEQ	C
06818000	Missouri River at St. Joseph	CE KC, DEQ	DC
06819500	One Hundred and Two River at Maryville	DGLS	D
06820500	Platte River near Agency	CE KC	D
06821140	Smithville Reservoir near Smithville	CE KC	R
06821150	Little Platte River at Smithville	CE KC	D
06821190	Platte River at Sharps Station	CE KC, USGS	DC
06893000	Missouri River at Kansas City	CE KC	D
06893500	Blue River near Kansas City	CE KC	D

<sup>1</sup>See footnote at end of table for explanation of abbreviations.

Table 1.--Daily discharge and surface-water quality stations in operation during fiscal year 1987--Continued

Station number	Station name	Cooperation <sup>1</sup>	Type of data <sup>1</sup>
06893590	Blue River at 12th Street in Kansas City	CE KC	St
06893793	Little Blue River below Longview damsite in Kansas City	CE KC	D
06893890	East Fork Little Blue River near Blue Springs	CE KC	D
06894000	Little Blue River near Lake City	CE KC	D
06895500	Missouri River at Waverly	CE KC	D
06897500	Grand River near Gallatin	CE KC	D
06899500	Thompson River at Trenton	CE KC	D
06899620	Thompson River near Chillicothe	DEQ	C
06900000	Medicine Creek near Galt	DGLS	D
06902000	Grand River near Sumner	CE KC, DEQ, USGS	DC
06904050	Chariton River at Livonia	CE KC	D
06904500	Chariton River at Novinger	CE KC	D
06905500	Chariton River near Prairie Hill	CE KC	D
06906000	Mussel Fork near Musselfork	CE KC	D
06906190	Long Branch Lake near Macon	CE KC	R
06906200	East Fork Little Chariton River near Macon	CE KC	D
06906300	East Fork Little Chariton River near Huntsville	CE KC, DEQ	DC
06906500	Missouri River at Glasgow	CE KC	St
06908000	Blackwater River at Blue Lick	CE KC	D
06909000	Missouri River at Boonville	CE KC	D
06910230	Hinkson Creek near Columbia	DC	DT
06910410	Cedar Creek near Columbia	LRC	DCT
06910414	Cedar Creek near Ashland	DEQ	C
06910450	Missouri River at Jefferson City	UE	St
06918070	Osage River above Schell City	CE KC, USGS	DC
06918080	Osage River near Schell City	CE KC, USGS	S
06918440	Sac River near Dadeville	CE KC, DEQ	DC
06918460	Turnback Creek above Greenfield	CE KC	D
06918740	Little Sac River near Morrisville	CE KC	D
06918990	Stockton Lake near Stockton	CE KC	R
06919000	Sac River near Stockton	CE KC	D
06919020	Sac River below Stockton	CE KC	D
06919500	Cedar Creek near Pleasant View	CE KC	D
06919900	Sac River near Caplinger Mills	CE KC	D
06920500	Osage River at Osceola	CE KC	St

Table 1.--Daily discharge and surface-water quality stations in operation during fiscal year 1987--Continued

Station number	Station name	Cooperation <sup>1</sup>	Type of data <sup>1</sup>
06921070	Pomme de Terre River near Polk	CE KC, DGLS	D
06921200	Lindley Creek near Polk	CE KC	D
06921325	Pomme de Terre Lake near Hermitage	CE KC	R
06921350	Pomme de Terre River near Hermitage	CE KC	D
06921600	South Grand River at Urich	DEQ	C
06921770	South Grand River near Clinton	CE KC	D
06922190	West Fork Tebo Creek near Lewis	CE KC	C
06922440	Harry S. Truman Lake at Warsaw	CE KC	R
06922450	Osage River below Harry S. Truman Dam	CE KC	D
06922500	Osage River at Warsaw	CE KC	St
06922550	Osage River below Warsaw	CE KC	St
06922560	Lake of the Ozarks at Oar House Marina	CE KC	St
06922650	Lake of the Ozarks at Turkey Creek Cove	CE KC	St
06922790	Lake of the Ozarks above Buffalo Creek	CE KC	St
06922900	Lake of the Ozarks at Rainy Creek	CE KC	St
06923500	Bennett Spring at Bennett Springs	DGLS	D
06923700	Niangua River at Bennett Springs	DEQ	C
06925500	Lake of the Ozarks near Bagnell	DGLS	R
06926000	Osage River near Bagnell	UE	D
06926500	Osage River near St. Thomas	UE	D
06926510	Osage River below St. Thomas	USGS	C
06930450	Big Piney River at Devils Elbow	DEQ	C
06930800	Gasconade River above Jerome	USGS, DEQ	C
06932000	Little Piney Creek at Newburg	DGLS	D
06933500	Gasconade River at Jerome	DGLS	D
06934000	Gasconade River at Rich Fountain	CE KC	D
06934500	Missouri River at Hermann	CE KC, DEQ, USGS	DCT
06935965	Missouri River at St. Charles	CE STL	St
07010000	Mississippi River at St. Louis	CE STL, USGS	DST
07013000	Meramec River near Steelville	CE STL	D
07013050	Crooked Creek near Dillard	DEQ	C
07014500	Meramec River near Sullivan	CE STL, DEQ	DC
07015720	Bourbeuse River near Highgate	CE STL	D
07016400	Bourbeuse River above Union	DEQ	C
07016500	Bourbeuse River at Union	CE STL	D



Table 1.--Daily discharge and surface-water quality stations in operation during fiscal year 1987--Continued

Station number	Station name	Cooperation <sup>1</sup>	Type of data <sup>1</sup>
07017020	Meramec River at Pacific	CE STL	St
07017200	Big River at Irondale	CE STL	D
07018100	Big River near Richwoods	CE STL, DEQ	DC
07018500	Big River near Byrnesville	CE STL	D
07019000	Meramec River near Eureka	CE STL, USGS	DC
07019280	Meramec River at Paulina Hills	DEQ	C
07019300	Meramec River at Arnold	CE STL	St
07020500	Mississippi River at Chester, Ill.	CE STL	DST
07021000	Castor River at Zalma	DGLS	D
07022000	Mississippi River at Thebes, Ill.	CE STL, DEQ	DCST
07034000	St. Francis River near Roselle	CE STL	D
07035000	Little St. Francis River near Fredericktown	CE STL	D
07035800	St. Francis River near Mill Creek	CE STL	D
07036100	St. Francis River near Saco	CE STL, DEQ	DC
07036940	Big Creek at Chloride	DEQ	C
07037000	Big Creek at Des Arc	CE STL	D
07037500	St. Francis River near Patterson	CE STL	D
07039000	Wappapello Lake at Wappapello	CE STL	R
07039500	St. Francis River at Wappapello	CE STL	D
07042500	Little River ditch 251 near Lilbourn	DGLS	D
07043500	Little River ditch 1 near Morehouse	DGLS	D
07046001	Little River ditches near Kennett	DEQ	C
07050700	James River near Springfield	CU	D
07051600	James River near Wilsons Creek	DEQ	C
07052250	James River near Boaz	DEQ	C
07052500	James River at Galena	CE LR	D
07053400	Table Rock Lake near Branson	CE LR	R
07053450	White River below Table Rock Dam near Branson	CE LR	C
07053500	White River near Branson	CE LR	D
07053600	Lake Taneycomo at School of the Ozarks	CE LR	StCT
07053700	Lake Taneycomo at Branson	DEQ	C
07053820	Lake Taneycomo at Powersite Dam	CE LR	St
07057350	Tributary to Middle Indian Creek near Cabool	DEQ	DS
07057360	Middle Indian Creek near Cabool	DEQ	DS
07057500	North Fork River near Tecumseh	CE LR, DEQ	DC

Table 1.--Daily discharge and surface-water quality stations in operation during fiscal year 1987--Continued

Station number	Station name	Cooperation <sup>1</sup>	Type of data <sup>1</sup>
07061300	East Fork Black River at Lesterville	DGLS	D
07061500	Black River near Annapolis	CE LR	D
07062000	Clearwater Lake near Piedmont	CE LR	R
07062500	Black River at Leeper	CE LR	D
07063000	Black River at Poplar Bluff	CE LR, DEQ	DC
07064400	Montauk Springs at Montauk	NPS	C
07064440	Current River below Montauk State Park	NPS	C
07064530	Welch Spring near Akers	NPS	C
07064555	Pulltite Spring near Round Spring	NPS	C
07065000	Round Spring at Round Spring	NPS	C
07065500	Alley Spring at Alley	NPS	C
07066000	Jacks Fork at Eminence	DGLS	D
07066110	Jacks Fork above Two Rivers	NPS	C
07066510	Current River above Powder Mill	NPS	C
07066550	Blue Spring near Eminence	NPS	C
07067000	Current River at Van Buren	CE LR, DGLS	D
07067500	Big Spring near Van Buren	DGLS, NPS	DC
07067800	Current River below Hawes Campground	NPS	C
07068000	Current River at Doniphan	CE LR, DEQ	DC
07071000	Greer Spring at Greer	DGLS	D
07071500	Eleven Point River near Bardley	CE LR, DEQ, DGLS	DC
07186000	Spring River near Waco	CE TU	D
07186400	Center Creek near Carterville	DGLS, DEQ	DC
07186480	Center Creek near Smithfield	DEQ	C
07187000	Shoal Creek above Joplin	CE TU	D
07189000	Elk River at Tiff City	DEQ	C

<sup>1</sup>Explanation of abbreviations:

Cooperation

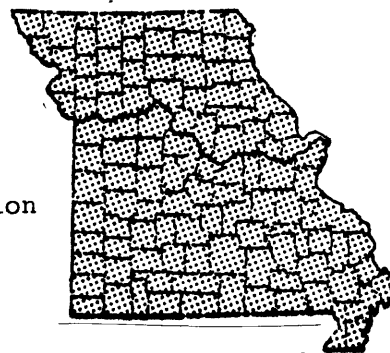
CE KC	U.S. Army, Corps of Engineers, Kansas City
CE LR	U.S. Army, Corps of Engineers, Little Rock
CE RI	U.S. Army, Corps of Engineers, Rock Island
CE STL	U.S. Army, Corps of Engineers, St. Louis
CE TU	U.S. Army, Corps of Engineers, Tulsa
CU	City Utilities of Springfield
DEQ	Missouri Division of Environmental Quality
DGLS	Missouri Division of Geology and Land Survey
UE	Union Electric Company of Missouri
NPS	National Park Service
SCS	Soil Conservation Service
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
LRC	Missouri Land Reclamation Commission
DC	Missouri Department of Conservation

Type of data

C	- Chemical
D	- Discharge--continuous record of stage and discharge
R	- Reservoir content
S	- Sediment
St	- Stage only
T	- Temperature

PROJECT TITLE: Collection of Surface-Water Data

COOPERATORS: City Utilities of Springfield  
Little River Drainage District  
Missouri Department of Natural Resources  
Division of Geology and Land Survey  
Missouri Highway and Transportation Commission  
Missouri Park Board  
Union Electric Company of Missouri  
U.S. Army, Corps of Engineers



PROJECT NUMBER: MO 00-001

PROJECT CHIEF: L.A. Waite

LOCATION: Statewide

#### NEED FOR STUDY

Surface-water information is needed for surveillance, planning, design, hazard warning, and operation and management in water-related fields, such as water supply, hydroelectric power, flood control, irrigation, bridge and culvert design, wildlife management, contamination abatement, and waste disposal.

#### OBJECTIVES

(1) To collect surface-water data sufficient to satisfy needs for current-purpose uses, such as assessment of water resources; operation of reservoirs or industries; forecasting; disposal of wastes, both common and nuclear; contamination controls; discharge data to accompany water-quality measurements; compact and legal requirements; and research of special studies. (2) To collect data necessary for analytical studies and define the trends and statistical properties of streamflow.

#### APPROACH

Standard methods of data collection will be used as described in the series Techniques of Water-Resources Investigations of the U.S. Geological Survey.

#### ACTIVITIES DURING FISCAL YEAR 1986

The 1985 annual water-data report was completed and submitted to the U.S. Government Printing Office in August 1986; printed copies were distributed to cooperators and other Federal agencies.

#### PROPOSED ACTIVITIES DURING FISCAL YEAR 1987

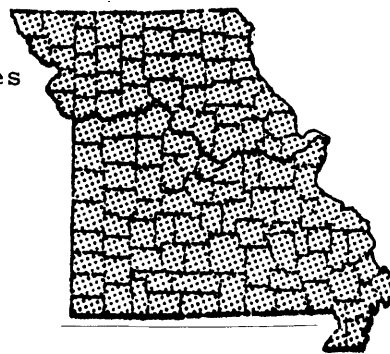
Data collection will continue, and a date of July 1987 is anticipated for completion of the 1986 water-data report.

Project MO 00-001--Continued

REPORTS

- Waite, L.A., and Alexander, T.W., 1987, Floods of December 1982 in southeastern Missouri: U.S. Geological Survey Hydrologic Investigations Atlas HA-689, 1 sheet.
- Waite, L.A., Davis, J.V., Reed, H.L., Hatten, D.O., and Perkins, T.J., 1985, Water resources data, Missouri, water year 1984: U.S. Geological Survey Water-Data Report MO-84-1, 329 p. (published annually).
- Waite, L.A., Davis, J.V., Reed, H.L., Perkins, T.J., and Hatten, D.O., 1986, Water resources data, Missouri, water year 1985: U.S. Geological Survey Water-Data Report MO-85-1, 320 p. (published annually).
- \_\_\_\_\_, 1987, Water resources data, Missouri, water year 1986: U.S. Geological Survey Water-Data Report MO-86-1, 325 p. (published annually).

PROJECT TITLE: Collection of Ground-Water Data  
COOPERATOR: Missouri Department of Natural Resources  
Division of Geology and Land Survey  
PROJECT NUMBER: MO 00-002  
PROJECT CHIEF: L.F. Emmett  
LOCATION: Statewide



#### NEED FOR STUDY

Ground-water information is needed to evaluate the effects of climatic variations on recharge to and discharge from the aquifer systems, to provide a data base for measuring the effects of development, to assist in the prediction of future supplies, and to provide data for management of the resources.

#### OBJECTIVES

(1) To collect sufficient data to provide a long-term data base so that the general response of the hydrologic system to natural climatic variations and induced stresses is known to allow for proper planning and management of potential concerns in the state. (2) To provide a data base from which the short-term records acquired in areal studies can be analyzed.

#### APPROACH

Evaluation of regional geology allows broad, general definition of aquifer systems and their boundary conditions. Within this framework, data will be collected to help define stresses on the system and the hydrologic properties of the aquifers. The data-collection network will be refined as records accumulate and detailed areal studies of the ground-water system more closely define the aquifers, their properties, and the stresses to which they are subjected.

#### ACTIVITIES DURING FISCAL YEAR 1986

Water-levels measurements were made in all network wells during the spring of 1986. Included in the network are wells in Audrain, Barton, Bates, and Vernon Counties and wells in those counties that comprise the Mississippi Alluvial Plain.

#### PROPOSED ACTIVITIES DURING FISCAL YEAR 1987

Make water-level measurements in all network wells during October 1986 after the irrigation season is over, and make water-level measurements again during April 1987 before the beginning of the 1987 irrigation season. In addition, hydrographs will be prepared for each of the 54 wells that the Missouri Division of Geology and Land Survey maintains a continuous water-level recorder.

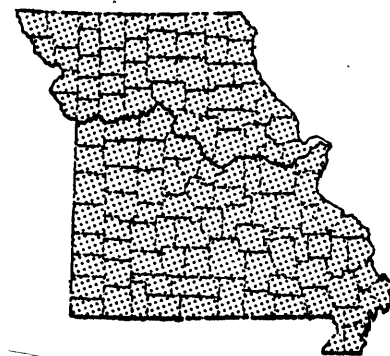
PROJECT TITLE: Collection of Quality-Water Data

COOPERATORS: Missouri Department of Natural Resources  
Division of Environmental Quality  
Land Reclamation Commission  
National Park Service  
U.S. Army, Corps of Engineers

PROJECT NUMBER: MO 00-003

PROJECT CHIEF: J.V. Davis

LOCATION: Statewide



#### NEED FOR STUDY

Water-resource planning and water-quality assessment require a statewide and nationwide base of relatively standardized information. For planning and realistic assessment of the water resources, the chemical and physical quality of the rivers and streams need to be defined and monitored.

#### OBJECTIVES

(1) To collect sufficient data to provide a long-term data base so that the general water quality of the hydrologic system is known to allow for proper planning and management of potential concerns in the State. (2) To collect data necessary for analytical studies and define the trends and statistical properties of water-quality conditions.

#### APPROACH

Operation of a network of quality-water stations to measure chemical concentrations, loads, and time trends as required by planning and management agencies.

#### ACTIVITIES DURING FISCAL YEAR 1986

The Missouri water-quality network included 14 NASQAN stations: 10 were sampled bimonthly, 4 were sampled quarterly, and 1 also was sampled daily for temperature and specific conductance. Division of Environmental Quality stations included 33 monthly sampling sites, 3 bimonthly sampling sites, and 3 sites where samples were collected 8 times. Samples were collected monthly at one site for the Land Reclamation Commission; in addition, a minimonitor that measures pH and specific conductance was operated at the site. Samples were collected monthly at 1 site for the Corps of Engineers and biannually at 11 sites for the National Park Service. Minimonitors that measure temperature and dissolved oxygen were operated at three stations, one for the Corps of Engineers and two for the Division of Environmental Quality.

Project MO 00-003--Continued

PROPOSED ACTIVITIES DURING FISCAL YEAR 1987

NASQAN samples will be collected at seven sites bimonthly, three sites quarterly, and at one site daily for temperature and specific conductance. Stations operated in cooperation with the Division of Environmental Quality will include 30 monthly sampling sites, 1 bimonthly sampling sites, 2 sampling sites where samples will be collected 8 times, and 1 sampling site where samples will be collected 2 times. Samples will be collected monthly at 1 site for the Corps of Engineers, monthly at 1 site for the Land Reclamation Commission, and biannually at 11 sites for the National Park Service. Two minimonitors, one that measures temperature and dissolved oxygen and one that measures pH and specific conductance, will be operated.

REPORTS

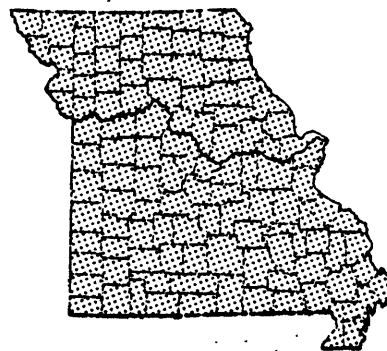
Waite, L.A., Davis, J.V., Reed, H.L., Hatten, D.O., and Perkins, T.J., 1985, Water resources data, Missouri, water year 1984: U.S. Geological Survey Water-Data Report MO-84-1, 329 p. (published annually).

Waite, L.A., Davis, J.V., Reed, H.L., Perkins, T.J., and Hatten, D.O., 1986, Water resources data, Missouri, water year 1985: U.S. Geological Survey Water-Data Report MO-85-1, 320 p. (published annually).

\_\_\_\_ 1987, Water resources data, Missouri, water year 1986: U.S. Geological Survey Water-Data Report MO-86-1, 325 p. (published annually).



PROJECT TITLE: Collection of Sediment Data  
COOPERATOR: U.S. Army, Corps of Engineers  
PROJECT NUMBER: MO 00-004  
PROJECT CHIEF: W.R. Berkas  
LOCATION: Statewide



#### NEED FOR STUDY

Water-resources planning and water-quality assessment require a nationwide base level of relatively standardized information. Sediment concentrations and discharges in Missouri's rivers and streams need to be defined and monitored.

#### OBJECTIVE

Provide sediment data for use in broad State and Federal planning and action programs, including State and Federal management of interstate and international waters.

#### APPROACH

Establish and operate a network of sediment stations to provide spatial and temporal averages and trends of sediment concentration, sediment discharge, and particle size of sediment being transported by rivers and streams.

#### ACTIVITIES DURING FISCAL YEAR 1986

Continue the operation of nine sediment-sampling stations and publish the records in "Water Resources Data, Missouri", published annually.

#### PROPOSED ACTIVITIES DURING FISCAL YEAR 1987

Continue collecting daily sediment data at nine sediment-sampling stations.

#### REPORTS

Waite, L.A., Davis, J.V., Reed, H.L., Hatten, D.O., and Perkins, T.J., 1985, Water resources data, Missouri, water year 1984: U.S. Geological Survey Water-Data Report MO-84-1, 329 p. (published annually).

Waite, L.A., Davis, J.V., Reed, H.L., Perkins, T.J., and Hatten, D.O., 1986, Water resources data, Missouri, water year 1985: U.S. Geological Survey Water-Data Report MO-85-1, 320 p. (published annually).

\_\_\_\_\_, 1987, Water resources data, Missouri, water year 1986: U.S. Geological Survey Water-Data Report MO-86-1, 325 p. (published annually).

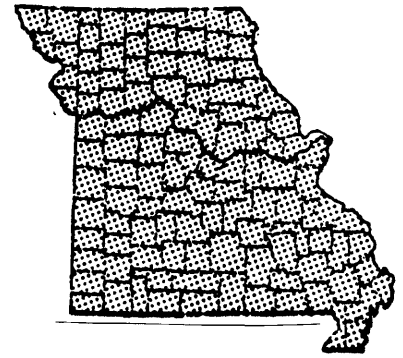
PROJECT TITLE: Water-Use Data-Collection and Reporting  
Program for Missouri

COOPERATOR: Missouri Department of Natural Resources  
Division of Geology and Land Survey

PROJECT NUMBER: MO 00-007

PROJECT CHIEF: D.C. Hall

LOCATION: Statewide



#### NEED FOR STUDY

As population increases and industry expands to meet the needs of that population, demand for and use of water will increase. This places a two-fold stress on the water supply. The increased demand may exceed the supply, and increased use accelerates the potential for degradation of the water quality.

#### OBJECTIVES

(1) To systematically collect data for the estimation of the withdrawal and return of water for all types of water uses; (2) to provide a broad data base from which many types of analyses can be made; (3) to provide a greater knowledge of the general hydrologic effects of increased withdrawals from the water system; and (4) to provide data to the national water-use data base to assist in the national water-resources assessment.

#### APPROACH

Water-use data will be collected by categories on a statewide basis. Existing data will be compiled from State files, stored in the U.S. Geological Survey Prime computer system, and entered into the U.S. Geological Survey aggregated data base. Data-collection methods and sampling strategies will be devised to acquire additional data. A report will be planned to describe data-collection methods and sampling strategies. Statistical summaries will be included in the annual water-data report.

#### ACTIVITIES DURING FISCAL YEAR 1986

Water use for 1984 was compiled. Estimates of water use in Missouri for 1985 for 12 categories were entered into the National Water-Use Data System (NWUDS). Data were prepared for publication in 1987 National Water Summary "Estimated Water Use in the United States in 1985."

#### PROPOSED ACTIVITIES DURING FISCAL YEAR 1987

Compilation of water-use data for 1981 to 1986 will be completed, and data will be entered into the State Water-Use Data System (SWUDS). Water-use-reporting forms for 1985 and 1986 will be revised and mailed. 1986 estimated water-use data will be assembled and entered into the NWUDS. The section on water use in Missouri will be prepared for the 1987 National Water Summary. First draft of report in cooperation with the Division of Geology and Land Survey summarizing 1985 water use in Missouri will be completed.

Project MO-007--Continued

REPORT

Hall, D.C., and Steelman, S.H., in press, Missouri water supply and demand, in  
National Water Summary 1987--Hydrologic events and water supply and  
demand: U.S. Geological Survey Water-Supply Paper 2350.

## AREAL HYDROLOGIC INVESTIGATIONS

Interpretive investigations in Missouri include local, county, and state-wide studies. Some of the anticipated uses of the results of these investigations include determining runoff characteristics, water quality, water temperature, and sediment loads of Missouri streams; defining floodflows at ungaged rural areas of Missouri; appraising of the water resources to determine the availability and quality of water for irrigation; identifying and monitoring of surface and ground water affected by acid-mine drainage; and determining the effects of hazardous-waste disposal on surface and ground water in Missouri.

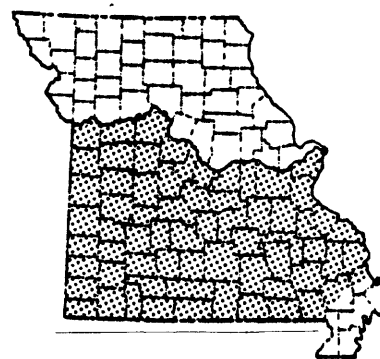
PROJECT TITLE: Hydrogeology of the Paleozoic Aquifers  
in Southern Missouri

COOPERATOR: Federal Program

PROJECT NUMBER: MO 81-047

PROJECT CHIEF: L.F. Emmett

LOCATION: Southern Missouri



#### NEED FOR STUDY

Increased use of ground water has caused conflicts among water users. In addition, a new awareness of the potential for contamination and water-quality deterioration is increasing the need to understand water-quality variations. Public demand eventually can be expected to result in methods to manage the resource to obtain maximum use with minimum deterioration. Successful management plans need to be based on factual data collated in a quantitative description of the flow system. Such an understanding does not now exist, but is a prerequisite to further progress in the development of the resource. The U.S. Geological Survey, as a part of the Regional Aquifer-System Analysis program, has begun a hydrologic investigation of the regional-flow system in Kansas, Oklahoma, Nebraska, eastern Colorado, southern Missouri, and northern Arkansas. This study, known as the Central Midwest Aquifer-System Analysis, will evaluate the potential of water contained in the regional aquifer system for use and management.

#### OBJECTIVES

To provide the regional aquifer study with concepts and data that will allow evaluation of the water-supply potential of the aquifers and to evaluate the response of the aquifers to projected development. More specifically, the study is designed to: (1) Describe the geologic, hydrologic, and water-quality characteristics and the hydrologic boundaries of the aquifers; (2) develop a regional data base on water-use, hydrologic, and geologic characteristics; (3) describe the past, present, and future concerns associated with water use; and (4) evaluate the responses of the aquifers to possible future changes in land use and pumpage.

#### APPROACH

From existing data construct a preliminary digital model of southern Missouri to test the conceptual model and to determine sensitivity of system to transmissivity, storage, vertical permeability, and boundaries. Use model to select areas for supplemental hydrogeologic data collection. Attempt to delineate recharge areas using geologic concepts and streamflow data. Use hydrograph-separation techniques and ground-water levels to estimate discharge to streams. Refine digital model of the aquifers using revised estimates of recharge, discharge, and water use. Determine location and movement of fresh-saltwater transition zone in response to pumpage. If practical, use computer-simulation techniques to predict saltwater movement in response to pumpage.

PROJECT MO 80-047--Continued

ACTIVITIES DURING FISCAL YEAR 1986

Hydrologic Investigations Atlas Chapters E-G were completed and received Director's approval.

PROPOSED ACTIVITIES DURING FISCAL YEAR 1987

Complete and submit a map report describing the geohydrologic units of southern Missouri by J.L. Imes and B.J. Smith for Director's approval for publication as a Hydrologic Investigations Atlas. Complete and submit three map reports describing the water quality in the Ozark aquifer system by J.L. Imes and J.V. Davis for Director's approval for publication as Hydrologic Investigations Atlases. Complete and submit a report describing the geohydrology and modeling analysis of the Ozark Plateaus aquifer system by J.L. Imes and L.F. Emmett for Director's approval for publication as a Professional Paper.

REPORTS

Imes, J.L., in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-A, 1 sheet.

\_\_\_\_\_ in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma--Basement confining unit: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-B, 1 sheet.

\_\_\_\_\_ in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma--St. Francois aquifer: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-C, 2 sheets.

\_\_\_\_\_ in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma--St. Francois confining layer: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-D, 3 sheets.

\_\_\_\_\_ in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma--Ozark aquifer: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-E, 3 sheets.

\_\_\_\_\_ in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma--Ozark confining layer: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-F, 3 sheets.

\_\_\_\_\_ in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma--Springfield Plateau aquifer: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-G, 3 sheets.

\_\_\_\_\_ in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma--Western Interior Plains confining system: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-H, 3 sheets.

Project MO 81-047--Continued

REPORTS--Continued

Imes, J.L., and Davis, J.V., in press, Water type and concentration of dissolved solids, chloride, and sulfate in ground water from the St. Francois aquifer in Missouri: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-J, 1 sheet.

\_\_\_\_\_ in press, Water type and concentration of dissolved solids, chloride, and sulfate in ground water from the Ozark aquifer in Missouri, Arkansas, Kansas, and Oklahoma: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-K, 4 sheets.

\_\_\_\_\_ in press, Water type and concentration of dissolved solids, chloride, and sulfate in ground water from the Springfield Plateau aquifer in Missouri, Arkansas, Kansas, and Oklahoma: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-L, 2 sheets.

Imes, J.L., and Smith, B.J., in press, Areal extent, stratigraphic relation, and geohydrologic properties of regional geohydrologic units in southern Missouri: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-I, 3 sheets.

Jorgensen, D.G., Helgesen, J.O., and Imes, J.L., in press, Regional aquifers in Kansas, Nebraska, and parts of Arkansas, Colorado, Missouri, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming--Geologic framework: U.S. Geological Survey Professional Paper 1414-B.

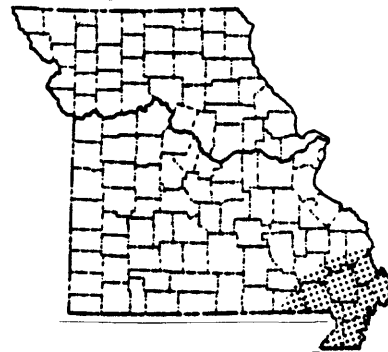
PROJECT TITLE: Hydrogeology of Southeastern Missouri

COOPERATOR: Federal Program

PROJECT NUMBER: MO 82-052

PROJECT CHIEF: T.O. Mesko

LOCATION: Southeastern Missouri



#### NEED FOR STUDY

Alluvial, Tertiary, Cretaceous, and Paleozoic aquifers are the principal sources of domestic, municipal, industrial, and agricultural water supplies in the Mississippi Alluvial Plain of southeastern Missouri. A quantitative analysis of the flow system, quality, and use of the ground-water resources is needed to manage the resources effectively.

#### OBJECTIVES

To provide the West Gulf Coast Regional Aquifer-Systems Analysis with concepts and data that will allow evaluation of the water-supply potential of the aquifers and their response to projected development. The study is designed to describe the geologic, hydrologic, and water-quality characteristics of the aquifers; develop a regional data base on water use, geologic, hydrologic, and water-quality information; and determine the recharge from the Ozark Plateaus to the aquifers in the Mississippi Alluvial Plain.

#### APPROACH

Compile and analyze existing geologic, hydrologic, and water-use data. Inventory wells completed in aquifers of Tertiary, Cretaceous, and Paleozoic age. Make onsite measurements and analyze water samples from 50 to 75 wells for major inorganic constituents and selected radioelements and isotopes. Perform hydraulic testing, geophysical logging, and water-quality sampling in selected wells to determine vertical differences. Prepare geologic, potentiometric-surface, and water-quality maps. A ground-water model will be completed relating the Paleozoic and Cretaceous aquifers to overlying aquifers.

#### ACTIVITIES DURING FISCAL YEAR 1986

A three-sheet map series that described and correlated the subsurface geology and stratigraphy of southeastern Missouri with that of Arkansas and Tennessee received Director's approval for publication as a Miscellaneous Investigations Map. Geochemical data were published in an Open-File Report. A report describing the hydrology and preliminary assessment of regional flow received Director's approval for publication as a Water-Resources Investigations Report.

#### PROPOSED ACTIVITIES DURING FISCAL YEAR 1987

Construct and analyze flow model of southeastern Missouri. Prepare Professional Paper to be authored by T.O. Mesko and J.V. Brahana. Complete and submit a map report about the geohydrology and water quality of Cenozoic and Mesozoic units for Director's approval for publication as a Hydrologic Investigations Atlas.



Project MO 80-052--Continued

REPORTS

- Brahana, J.V., and Mesko, T.O., in press, Hydrogeology and preliminary assessment of regional flow in the upper Cretaceous and adjacent aquifers in the northern Mississippi embayment: U.S. Geological Survey Water-Resources Investigations Report 87-4000.
- Brahana, J.V., Mesko, T.O., Busby, J.F., and Kraemer, T.F., 1985, Ground-water quality data from the northern Mississippi embayment--Arkansas, Missouri, Kentucky, Tennessee, and Mississippi: U.S. Geological Survey Open-File Report 85-683, 15 p.
- Mesko, T.O., in press, Subsurface geology of Paleozoic, Mesozoic, and Cenozoic units of southeastern Missouri: U.S. Geological Survey Miscellaneous Investigations Series I-1875, 3 sheets.

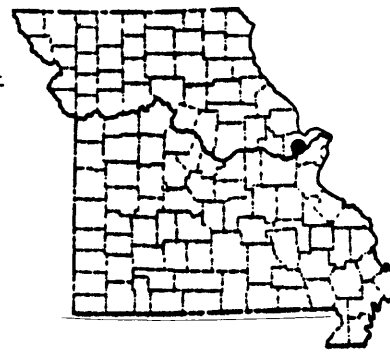
PROJECT TITLE: Potential Effects of Hazardous Wastes  
on the Hydrologic System in the Weldon  
Spring Area, St. Charles County, Missouri

COOPERATOR: Federal Program

PROJECT NUMBER: MO 84-059

PROJECT CHIEF: L.F. Emmett

LOCATION: Eastern Missouri



#### NEED FOR STUDY

The Weldon Spring Chemical Plant was used by the Atomic Energy Commission from 1957 to 1966 to process uranium and thorium. Residues from the operation were disposed of in four pits having a combined volume of 220,000 cubic yards. An abandoned limestone quarry about 3 miles southwest of the pits was used for the burial of contaminated solids and radioactive residues from various processing sites. Disposal of these radioactive wastes in an area underlain by carbonate rocks has created the potential for contamination of the surface and ground water.

#### OBJECTIVES

(1) Determine the extent and magnitude of contamination of the surface and ground water from the pits and quarry; (2) describe the ground-water-flow system in the study area, including the hydrologic boundaries; (3) describe the hydrogeologic characteristics of the aquifers underlying the area; (4) determine the surface-ground water relation; and (5) describe the chemical quality of the surface and ground water.

#### APPROACH

The first year of the 3-year project will include the compilation and analysis of available hydrologic information, collection of synoptic field data, and the preparation of a planning report that will summarize available hydrologic data and indicate where additional data are needed. Work during the last 2 years of the project will consist of test-hole drilling, aquifer testing, water-level measurements in wells, collection of water samples for chemical analysis, and preparation of a final report.

#### ACTIVITIES DURING FISCAL YEAR 1986

Completed a planning report that summarized extensive data collected by previous investigators, presented a preliminary interpretation of the hydrologic data, and outlined needed additional data collection. Installed ten monitoring wells and collected water samples from surface- and ground-water sites.

#### PROPOSED ACTIVITIES DURING FISCAL YEAR 1987

Complete a basic data report that presents hydrologic and water-quality data collected from 1984 to 1986. Also complete and submit the final report that describes the hydrology and water quality by M.J. Kleeschulte and L.F. Emmett for Director's approval as a Water-Resources Investigations Report.

Project MO 84-059--Continued

REPORTS

Kleeschulte, M.J., and Emmett, L.F., 1986, Compilation and preliminary interpretation of hydrologic data for the Weldon Spring radioactive waste-disposal sites, St. Charles County, Missouri--A progress report: U.S. Geological Survey Water-Resources Investigations Report 85-4272, 71 p.

\_\_\_\_\_ 1987, Hydrology and water quality at the Weldon Spring radioactive waste-disposal sites, St. Charles County, Missouri: U.S. Geological Survey Water-Resources Investigations Report 87-4169, 65 p.

Kleeschulte, M.J., Emmett, L.F., and Barks, J.H., 1986, Hydrologic data for the Weldon Spring radioactive waste-disposal sites, St. Charles County, Missouri--1984-1986: U.S. Geological Survey Open-File Report 86-488, 61 p.

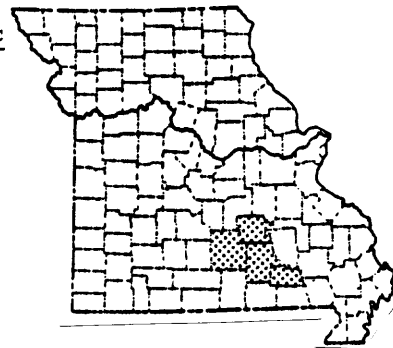
PROJECT TITLE: Flood Characteristics and Flood-Hazard  
Delineation in the Ozark National Scenic  
Riverways, Southeastern Missouri

COOPERATOR: National Park Service

PROJECT NUMBER: MO 84-061

PROJECT CHIEF: T.W. Alexander

LOCATION: Southeastern Missouri



#### NEED FOR STUDY

About 95 percent of the development within the Ozark National Scenic Riverways lies within the estimated 100-year flood plain. The safety of visitors who might be subjected to possible flooding hazards is a primary concern. A flood-hazard survey is needed to help manage the flood plains for visitor safety and property protection.

#### OBJECTIVES

A determination of the 100- and 500-year flood elevations and an evaluation of critical factors, such as basin lag time and duration of flooding, will be made at four to six extensively used area developments along the Current River and Jacks Fork.

#### APPROACH

Existing data will be compiled. The slope-conveyance or modified step-backwater methods will be used to generate the 100- and 500-year flood profile; therefore, field survey work (channel-cross sections) will be needed at each development of interest. The four continuous-recording stations on the mainstems (Current River and Jacks Fork) and a basin model (HEC-1) will be used to help generate data needed at each location.

#### ACTIVITIES DURING FISCAL YEAR 1986

Flood profiles (100- and 500-year) and evaluation of the critical factors (basin lag and duration of flooding) have been completed for the Akers and Alley Spring developments. Chapter A about these two developments was submitted for Director's approval for publication as a Hydrologic Investigations Atlas.

#### PROPOSED ACTIVITIES DURING FISCAL YEAR 1987

The flood profile and evaluation of the critical basin factors will be completed for the Round Spring and Powder Mill developments. Chapter B about these two developments will be submitted for Director's approval for publication as a Hydrologic Investigations Atlas.

PROJECT MO 84-061--Continued

REPORTS

Alexander, T.W., in press, Delineation of flooding within the Ozark National Scenic Riverways in southeastern Missouri--Akers and Alley Spring: U.S. Geological Survey Hydrologic Investigations Atlas HA 712-A, 3 sheets.

\_\_\_\_\_ in press, Delineation of flooding within the Ozark National Scenic Riverways in southeastern Missouri--Round Spring and Powder Mill: U.S. Geological Survey Hydrologic Investigations Atlas HA 712-B, 3 sheets.

PROJECT TITLE: Hydrology of Abandoned Strip Mines  
and Effects of Reclamation at the  
Power Mine in Western Missouri

COOPERATOR: Missouri Department of Natural Resources  
Division of Environmental Quality  
Land Reclamation Commission

PROJECT NUMBER: MO 85-062

PROJECT CHIEF: D.W. Blevins

LOCATION: Western Missouri



#### NEED FOR STUDY

About 2,750 acres of abandoned strip mines in western Missouri are characterized by barren spoil and acid water. The Land Reclamation Commission is considering revegetating the area, but there is insufficient information about the factors that control water quality to determine whether revegetation efforts will improve the acidic condition of the lakes and streams in the area.

#### OBJECTIVES

To determine the movement and quality of surface and ground water; determine the interchange between the surface- and ground-water systems; and determine the effects of revegetation activities on the quantity and quality of surface discharge from the strip-mined area.

#### APPROACH

Existing information will be compiled with reconnaissance data to develop a conceptual hydrologic model of the basin. Continuous rainfall-runoff and surface-water-quality data will be collected to determine runoff quality and the origin of acidic water in the lakes. Ground-water and spoil samples (including isotope data) will be collected to determine the geochemistry and contribution of ground water to acidic lakes. Ground-water levels will be used to determine the direction of ground-water flow in the spoil. A water-quality computer model will be used to broaden the results and evaluate details of the hydrologic system where they are missing. Two long-term streamflow-gaging stations and two water-quality monitors will be operated to monitor the effects of revegetation on water quality.

#### ACTIVITIES DURING FISCAL YEAR 1986

Discharge, pH, and specific conductance were continuously measured at two sites, and rainfall was measured at one station. Runoff samples were collected, and two sets of water samples were collected from 19 surface-water sites and 10 mine-spoil wells. The geometry of 17 lakes was determined, and water levels in 11 small lakes were monitored. Ground-water levels were monitored in 20 wells drilled into mine spoil. Sulfur- and oxygen-isotope analyses were completed on both mine spoil and spoil water. Data analysis and water-quality modeling were begun.

Project MO 85-062--Continued

PROPOSED ACTIVITIES DURING FISCAL YEAR 1987

Complete data analysis and modeling. Complete report for publication as a U.S. Geological Survey Water-Resources Investigations Report.

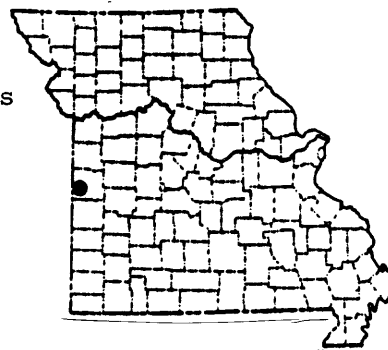
PROJECT TITLE: Hydrology of the Tiger Mine Area,  
Bates County, Missouri

COOPERATOR: Missouri Department of Natural Resources  
Division of Environmental Quality  
Land Reclamation Commission

PROJECT NUMBER: MO 85-062A

PROJECT CHIEF: T.O. Mesko

LOCATION: Western Missouri



#### NEED FOR STUDY

The Tiger-Worland mine site was an active surface coal mine from mid-1931 to early 1934. After mining operations closed, the processing plant at the site continued operations, and the site was used as a coal refuse disposal site until 1957. About 275 acres of land have been disturbed by mining and the subsequent coal refuse disposal. Several surface streams that drain the site are affected by acidic water seeping from the coal refuse piles. Local ground-water systems may be affected by leachates from the coal-waste disposal area and the surface-water impoundments bordering the site. The Land Reclamation Commission reclaimed the Tiger Mine site during 1984 and 1985.

#### OBJECTIVES

To determine, document, and analyze the movement and quality of surface and ground water at the site by: (1) Defining and evaluating the controlling factors of the hydrologic systems at the site; (2) evaluating existing data on the occurrence and quality of water in and near the site; and (3) making suggestions as to collection of additional data at the site.

#### APPROACH

Existing information will be compiled and analyzed. Determination will be made of types and location of additional data needed. Ground-water levels will be measured quarterly and used to determine the direction of ground-water flow at the site. An automatic-digital recorder and weir will be installed to record the gage height and discharge for an acidic spring at the site. Water from selected wells will be sampled and analyzed once for common inorganic constituents and trace elements. The acidic spring will be sampled quarterly for 1 year.

#### ACTIVITIES DURING FISCAL YEAR 1986

An aquifer test was conducted to determine hydrologic properties of water-bearing units at the site. Water levels were measured quarterly. Both surface and ground water were sampled and analyzed. A continuous recorder and weir were installed. Five additional monitoring wells were drilled. The final report was prepared.



PROJECT MO 85-062A--Continued

PROPOSED ACTIVITIES DURING FISCAL YEAR 1987

Submit report for colleague review and Director's approval for publication as a U.S. Geological Survey Water-Resources Investigations Report.

REPORT

Mesko, T.O., in press, Geohydrology of a coal-mining area, southwestern Bates County, Missouri: U.S. Geological Survey Water-Resources Investigations Report 87-4202.

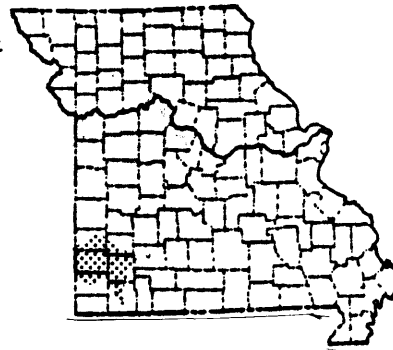
PROJECT TITLE: Water-Quality Characterization of  
Spring River Basin, Southwestern Missouri

COOPERATOR: Missouri Department of Natural Resources  
Division of Environmental Quality

PROJECT NUMBER: MO 85-065

PROJECT CHIEF: J.V. Davis

LOCATION: Southwestern Missouri



#### NEED FOR STUDY

About 20 to 30 NPDES (Nonpoint Discharge Effluent Source) permits will be reissued in southwestern Missouri during the next 3 years. Water-quality data have been collected in this area, and these data are stored in manual and computer files. Consolidation and analysis of these data by river basin are necessary to provide the basis for establishment of water-quality-based permit limits to be included in NPDES permits. Of particular interest are the Spring River and Center, Shoal, and Turkey Creeks in southwestern Missouri.

#### OBJECTIVES

To determine baseline water-quality characteristics of the Spring River and Center, Shoal, and Turkey Creeks for the purpose of establishing permit limits to protect water quality. Major sources of stream contamination, downstream effects, and assimilation of wastes in the streams also will be studied.

#### APPROACH

Phase 1 of the study involves the compilation of existing data and statistical analysis of the data to determine mean constituent concentration and baseline quality. Specific statistical techniques to be used include calculating the mean, median, standard deviation, and maximum and minimum concentrations of selected constituents. Correlation and time-trend analysis techniques, including linear regression and the nonparametric Kendall test, will be used. Phase 2 involves the collection of additional samples for chemical analyses, if necessary, to fill data voids, verify predicted baseline constituent concentrations, and determine effects of major contamination sources on water quality.

#### ACTIVITIES DURING FISCAL YEAR 1986

An extensive search and review of pertinent literature was completed. Existing data were compiled from various sources, including the U.S. Geological Survey, Water Resources Division, Missouri Division of Environmental Quality, Kansas Department of Health and Environment, and the U.S. Environmental Protection Agency. The sampling locations of the existing data were plotted on 1:250,000 and 1:24,000 scale maps showing areal distribution of nutrient, common inorganic, and trace-element analyses.

PROJECT MO 85-065--Continued

PROPOSED ACTIVITIES FOR FISCAL YEAR 1987

Compiled data not already in the data base will be entered into the Missouri District Quality Water Data (QWDATA) system in the Prime computer. Statistical analysis of the data will be undertaken and completed. Summary statistics, correlation, and time-trend analysis techniques will be used and a final report will be completed.

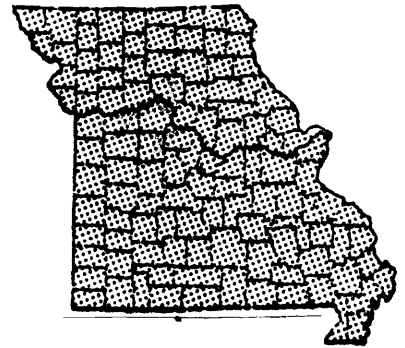
PROJECT TITLE: Identification of Hydrologic Information  
Describing Impacts of Pre-August 3, 1977,  
Non-Coal Mining on Water Resources of  
Missouri

COOPERATOR: Missouri Department of Natural Resources  
Division of Environmental Quality  
Land Reclamation Commission

PROJECT NUMBER: MO 85-066

PROJECT CHIEF: B.J. Smith

LOCATION: Statewide



#### NEED FOR STUDY

Missouri has been a major producer of metallic, nonmetallic, and fuel minerals since the 1700's; therefore, widespread abandoned minelands exist. The Land Reclamation Commission is responsible for identifying and evaluating the effect of abandoned mines on the environment and human health. The effect on water resources is a significant consideration. Serious water-resources issues exist in the Tri-State Mining District in southwestern Missouri and the Old Lead Belt in southeastern Missouri because of abandoned metal mines. Evaluation of the effect of all abandoned non-coal mines on water resources in the State is needed.

#### OBJECTIVES

To identify abandoned non-coal mines that are affecting water resources in Missouri and develop a scope of work for water resources investigations of sites that are most severely affected.

#### APPROACH

A summary will be made of all non-coal commodities mined in the State and a list of potential effects on water resources will be made for each commodity. The results will be evaluated and those commodities with potential effects will be selected for a detailed literature search for information about their effects on water quality. Results of the search will be compiled into a bibliography and mine areas with known or potential water-quality concerns will be identified. Those areas needing additional investigation will be described in a planning report.

#### ACTIVITIES DURING FISCAL YEAR 1986

A literature review and analysis identified mineral commodities that produced the most harmful effects on water resources, human health, and aquatic life. Areas with affected water resources were located, and areas that need additional study were delineated. A preliminary draft of the planning report was submitted for District review.

PROJECT MO 85-066--Continued

PROPOSED ACTIVITIES FOR FISCAL YEAR 1987

Submit report for colleague review and Director's approval for publication as a U.S. Geological Survey Water-Resources Investigations Report.

REPORT

Smith, B.J., in press, Assessment of water-quality in non-coal mining areas of Missouri: U.S. Geological Survey Water-Resources Investigations Report 87-4286.

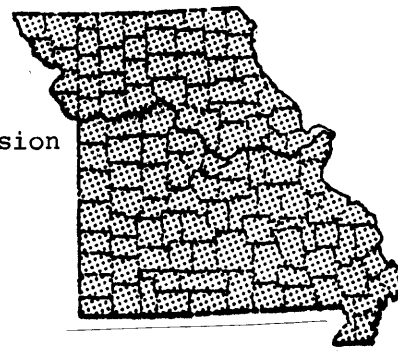
PROJECT TITLE: Techniques for Estimating Flood Hydrographs on Ungaged Streams for Risk Analysis

COOPERATOR: Missouri Highway and Transportation Commission

PROJECT NUMBER: MO 85-067

PROJECT CHIEF: L.D. Becker

LOCATION: Statewide



#### NEED FOR STUDY

Evaluation is needed of flood-related risks associated with the design of highway bridges and culverts in Missouri. Such risks include losses because of traffic interruption, upstream flood-plain encroachment, and damages to roadways and drainage structures. Discharge hydrographs are necessary to determine water-surface altitude at and upstream from roadways and to estimate inundation. Synthetic hydrographs are required at ungaged sites.

#### OBJECTIVES

(1) To investigate methods and develop techniques for estimating synthetic flood hydrographs at ungaged sites for selected design flood-frequency discharges and volumes. (2) Provide information necessary for risk analysis of highway-drainage structures for floods that can be expected to occur in Missouri.

#### APPROACH

Scope of the study is statewide and includes small rural and urban basins. Previously documented methods for estimating flood hydrographs to be investigated for use on Missouri streams include the Commons, Clark, and Soil Conservation Service (SCS) methods. These and other methods will be tested for applicability based on fitting synthetic hydrographs to observed hydrographs. If these methods are inadequate, attempts will be made to develop new techniques. Data required for this study are available from past rainfall-runoff investigations and other studies.

#### ACTIVITIES DURING FISCAL YEAR 1986

Long-term simulations were made for 43 rural and 39 urban small streams in Missouri. To obtain hydrograph volumes, a rainfall-runoff model was used with model calibration parameter values determined in prior studies. Log-Pearson type III statistical computations were made for use in determining magnitude and frequency of flood volumes. Work was begun on developing statewide flood-volume estimating equations based on multiple-regression techniques. Testing of several hydrograph estimation methods for possible use on small basins in Missouri was conducted.

PROJECT MO 85-067--Continued

PROPOSED ACTIVITIES FOR FISCAL YEAR 1987

Previously documented methods (Stricker and Sauer, 1982; Inman, 1986) have proven useful for investigation of Missouri streams. These general methods will be used, with modification, for fitting synthetic hydrographs to observed hydrographs and for final data analyses. Flood-volume estimating procedures will be developed. Data analyses will be completed. Preparation of report will begin documenting data analyses and study results for publication as a U.S. Geological Survey Water-Resources Investigations Report.

PROJECT TITLE: Effects of Special-Area Land Treatment  
on Sediment and Nutrient Transport in the  
Higginsville Reservoir Basin, Missouri

COOPERATOR: Missouri Department of Natural Resources  
Division of Environmental Quality

PROJECT NUMBER: MO 85-068

PROJECT CHIEF: D.W. Blevins

LOCATION: Northwestern Missouri



#### NEED FOR STUDY

Sediment and associated nutrients from agricultural lands are the principal nonpoint-source contaminants in streams and lakes in northern Missouri. A special-area land-treatment program is being implemented to decrease erosion in selected basins. The Higginsville Reservoir basin will be one of the first included in the program and has been selected for evaluation of effectiveness of the sediment-control project.

#### OBJECTIVES

To determine changes in suspended-sediment and nutrients loads in streams draining selected parts of Higginsville Reservoir basin as a result of implementing sediment-control practices. This information will complement a water-quality study of Higginsville Reservoir by the Division of Environmental Quality and the City of Higginsville. The studies will determine the collective effects of the land improvements on water quality in the basin.

#### APPROACH

Two data-collection stations will be implemented in the Higginsville Reservoir basin and one will be implemented as a control outside the basin. Continuous rainfall, streamflow, suspended-sediment, and nutrient data will be collected at each station. Some data will be manually collected to develop streamflow ratings and sediment coefficients. Sediment and nutrient loads will be computed for each station and related to collective land-use and seasonal changes. Statistical and graphical methods will be used for data analysis and, if sufficient data are available, basin modeling and sediment transport will be used to aid in transferring results to other basins.

#### ACTIVITIES DURING FISCAL YEAR 1986

Two rain gages and three stream-gaging and automatic sampling stations were installed. Several discharge measurements were made at all three stations for rating curve development. Runoff from four storms was sampled for nutrients, sediment, and suspended sediment. Agricultural practices were monitored to determine their effect on sediment yield and nutrient concentrations.



PROJECT MO 85-068--Continued

PROPOSED ACTIVITIES FOR FISCAL YEAR 1987

Runoff from two storms each, during the planting, growing, and harvesting of crops, will be sampled for sediment and nutrient concentration. Monitoring of agricultural practices will continue. Additional discharge measurements will be made for rating curve development. Data from a bottom sediment survey of Higginsville Lake will be used to compare sediment yield from 1924-1965 to 1965-1986.

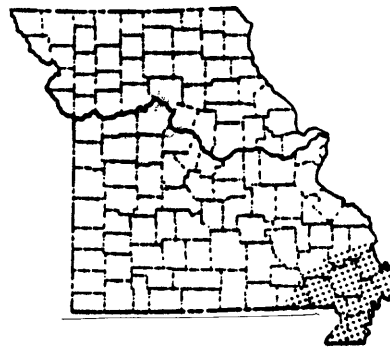
PROJECT TITLE: The Occurrence of Pesticides in Ground Water, Streams, and Streambed Sediment in the Southeast Lowlands of Missouri

COOPERATOR: Missouri Division of Health

PROJECT NUMBER: MO 86-069

PROJECT CHIEF: T.O. Mesko

LOCATION: Southeastern Missouri



#### NEED FOR STUDY

The Mississippi Alluvial Plain in southeastern Missouri is intensively farmed. The region produces cotton, rice, grain sorghum, wheat, soybeans, and corn. More than 2.3 million acres were harvested in 1984. An estimated 609,000 pounds and 671,000 gallons of pesticides were used in the area in 1984. The major pesticides are atrazine, trifluralin, alachlor, metachlor, cyanazine, propanil, and 2, 4-D. Increased and prolonged use of pesticides poses a potentially serious threat to ground- and surface-water supplies in the area.

#### OBJECTIVES

To identify and quantify pesticides that have the largest use in the area and to determine the occurrence of those pesticides in ground water, streams, and streambed sediment.

#### APPROACH

Types and quantities of pesticides used will be determined from sales statistics, agricultural data bases, crop types, extrapolation of crop-harvest and pesticide-application data, published literature, and survey of local, State, and Federal agencies. About 40 wells will be selected from irrigation, domestic, and public water-supply wells and will be sampled during spring 1986 (immediately following pesticide application) and in late fall 1986. Also, five surface-water and five bottom-sediment samples will be collected at selected stream sites for both sampling periods. Streamflow measurements will be made at the time of sample collection. Water levels in a well network will be measured during each sampling period.

#### ACTIVITIES DURING FISCAL YEAR 1986

Types and quantities of pesticides used in the area were determined. Sampling network was set up and samples were collected.

#### PROPOSED ACTIVITIES FOR FISCAL YEAR 1987

Additional wells were located and sampled. Samples were collected at all sites in the sampling network.

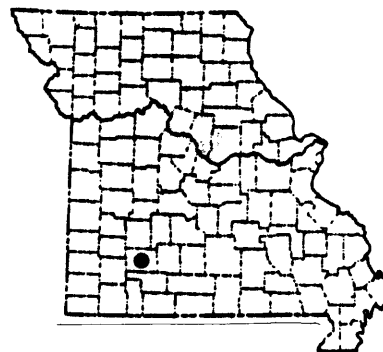
PROJECT TITLE: Ground-Water Resources of the Ozark  
Aquifer near Springfield, Missouri

COOPERATOR: City Utilities of Springfield

PROJECT NUMBER: MO 87-070

PROJECT CHIEF: J.L. Imes

LOCATION: Green County



#### NEED FOR STUDY

Large quantities of ground water presently are being pumped by the City of Springfield for municipal and industrial use. To meet the demands of an increasing population and industrial use, the city will need to drill one or more new water-supply wells. Previously drilled wells are open to the Ozark aquifer. Well casings are set from land surface to the base of the Ozark confining unit, isolating the surficial Springfield Plateau aquifer from the wells. A regional ground-water flow model indicates that the Ozark confining unit is leaky. The potential exists for movement of contaminants through the confining unit into existing and new water-supply wells.

#### OBJECTIVES

(1) Estimate the present rate of vertical leakage between the Springfield Plateau aquifer and Ozark aquifer under assumed future pumping rates. (2) Determine the effect of ground-water withdrawals in the Ozark aquifer on ground-water levels in the overlying Springfield Plateau aquifer. (3) Assess the potential effect of increased ground-water pumpage on vertical leakage rates and water levels in the Springfield Plateau aquifer. (4) Assess the potential for contamination of the Ozark aquifer by leakage through the Ozark confining unit.

#### APPROACH

A three-dimensional ground-water flow model of the area will be constructed and calibrated to assess the effect of increased pumpage from the Ozark aquifer. A mass measurement of ground-water levels will be made to compare current water levels with historical data in the calibration of the model.

#### PROPOSED ACTIVITIES FOR FISCAL YEAR 1987

The project was begun in May 1987. Proposed activities will include compilation and analysis of existing data, preparation of base maps, structure contour, and thickness maps of geohydrologic units necessary for the model, development of the primary model, and measurement of current ground-water levels in the study area.

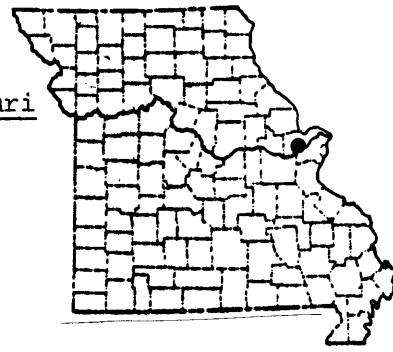
PROJECT TITLE: Extent and Magnitude of Contamination  
of the Water Resources in the Vicinity  
of the Weldon Spring Radioactive Waste-  
Disposal Sites, St. Charles County, Missouri

COOPERATOR: U.S. Department of Energy

PROJECT NUMBER: MO 87-071

PROJECT CHIEF: M.J. Kleeschulte

LOCATION: Eastern Missouri



#### NEED FOR STUDY

Chemical analyses indicate that water in the shallow bedrock aquifer contains large concentrations of calcium, lithium, magnesium, nitrate, sodium, strontium, sulfate, and uranium in the vicinity of four low-level radioactive waste-disposal pits. A spring 1.5 miles north of the site also has increased lithium, nitrate, and uranium concentrations, but monitoring wells between the pits and spring do not indicate a contamination plume. The areal and vertical extent and magnitude of contamination and the transport routes for the contaminants in this karst environment need to be defined.

#### OBJECTIVE

To define the extent, magnitude, and transport routes of contamination near the Weldon Spring Chemical Plant.

#### APPROACH

Gross water budget, infiltration tubes, and monitoring of precipitation will aid in the development of a ground-water flow model. Installation of continuous water-level recorders on wells will monitor ground-water fluctuations with changes in climatic conditions and the possible movement of the ground-water divide. Water-quality minimonitors installed at one contaminated spring and outflows from two contaminated ponds that drain into losing streams will record water-quality variations with climate and time.

Selected monitoring wells will be sampled, and water levels will be measured quarterly. Geochemical models will be used to evaluate geochemical controls. An interpretative report will be completed in the third year of the project. Water-quality conditions during remedial action will be monitored during the last 6 years of the project.

#### PROPOSED ACTIVITIES FOR FISCAL YEAR 1987

Minimonitors and continuous water-level recorders will be installed. Wells will be sampled and water levels will be measured during the fall of 1987.

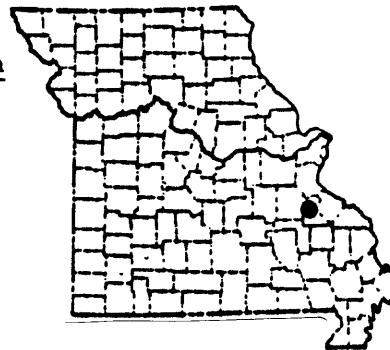
PROJECT TITLE: Effects of Lead and Zinc Mining on the  
Quality of Surface Water and Recent  
Alluvium in the Old Lead Belt of Southern  
Missouri

COOPERATOR: Missouri Department of Natural Resources  
Division of Environmental Quality  
Land Reclamation Commission

PROJECT NUMBER: MO 87-072

PROJECT CHIEF: B.J. Smith

LOCATION: Southeastern Missouri



#### NEED FOR STUDY

Tailings from mining operations were placed directly on the land surface and often close to streams. The Big River basin is estimated to contain 3,000 acres underlain by tailings. Six major tailings piles that can contain more than 500 acres each are in the area. These tailings contain unremoved particles of ore minerals that contribute lead, zinc, cadmium, iron, and copper to the environment. Mechanisms of contamination are dispersal of particles by wind, washing of particles by runoff into ponds and streams and subsequent transport of sediment downstream, slumping of tailings into streams, and leaching of metals by percolation of precipitation through tailings and subsequent movement of the dissolved metals or metal complexes into the ground- and surface-water systems.

#### OBJECTIVES

- (1) Determine the quality of surface water in the area, including tailings ponds, the Big River, the Flat River, and tributaries, at high and low stages.
- (2) Determine the physical and chemical processes that govern water quality.
- (3) Determine the metal content of various size fractions of suspended and bottom sediment.

#### APPROACH

A sampling network of 20 to 25 surface-water sites will be established at tailings ponds and streams. About 12 to 15 of the sites will be selected for suspended and bottom sediment sampling. Sampling and measuring will be done several times during the water year and will include both high and low stream discharge. Field parameters, common inorganics, total organic carbon, trace metals, and sulfur-34 and strontium 87/86 isotopes will be determined.

#### PROPOSED ACTIVITIES FOR FISCAL YEAR 1987

Existing data will be compiled concerning water quality, hydrology, and geology. Surface-water sampling sites will be established. Stream gages will be installed.

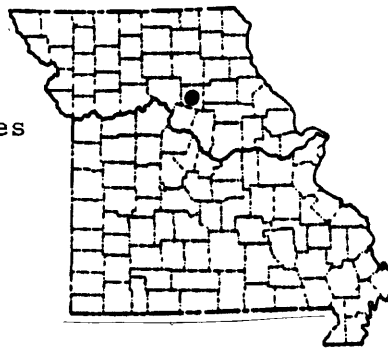
PROJECT TITLE: Mine Drainage and Subsidence Problems  
from Abandoned Underground Coal Mines  
at Huntsville, Missouri

COOPERATOR: Missouri Department of Natural Resources  
Division of Environmental Quality  
Land Reclamation Commission

PROJECT NUMBER: MO 87-073

PROJECT CHIEF: D.W. Blevins

LOCATION: Randolph County



#### NEED FOR STUDY

Shallow underground coal mining has caused concerns at Huntsville, Missouri. Degradation of the quality of water flowing through and emerging from the mines has occurred. Subsidence of the land surface also has caused significant damage to manmade structures.

#### OBJECTIVES

(1) Determine the location, seasonal variation, and effects of underground mine water on receiving streams and nearby ground water; (2) determine areas susceptible to surface subsidence from mine collapse; and (3) identify potential reclamation actions that could alleviate or minimize water-quality and subsidence concerns.

#### APPROACH

Locate mine workings from existing maps, geophysical techniques, subsidence features, entry locations, and wells drilled as part of this study. Geologic information will be obtained from surface mapping, drillers' logs, and literature. Water samples will be obtained from underground mines, and water levels, pH, and specific conductance will be continuously monitored. Existing wells will be inventoried to determine water levels and general ground-water quality in the area. Mine drainage sources will be identified, and flow from all significant sources will be sampled twice. Conceptual models of the ground-water flow and hydrogeochemical systems will be postulated.

#### PROPOSED ACTIVITIES FOR FISCAL YEAR 1987

Mine workings will be located. Available water-quality analyses will be compiled. Field reconnaissance will locate sources of mine drainage. One of two sets of water samples from underground mines and wells will be collected for analysis.

## SOURCES OF WATER RESOURCES DIVISION PUBLICATIONS AND INFORMATION

Selected references on water resources in Missouri are listed on the following pages, and many of these references are available for inspection at:

U.S. Geological Survey, WRD  
Missouri District  
1400 Independence Road  
Mail Stop 200  
Rolla, Missouri 65401

and

Missouri Division of Geology and Land Survey  
Fairgrounds Road  
P.O. Box 250  
Rolla, Missouri 65401

Current releases are described in a monthly pamphlet, "New Publications of the Geological Survey," which may be obtained from:

Books and Open-File Reports  
U.S. Geological Survey  
Federal Center, Bldg. 810  
Box 25425  
Denver, Colorado 80225

Professional Papers, Bulletins, Water-Supply Papers, Techniques of Water-Resources Investigations, Earthquake Information Bulletins, and popular leaflets, pamphlets, and booklets may be purchased from Books and Open-File Reports, Denver, Colorado (address above); additional information is given in "A Guide to Obtaining Information from the U.S. Geological Survey, 1982," Geological Survey Circular 900, which is available without cost from Books and Open-File Reports, Denver, Colorado.

Open-File and Water-Resources Investigations Reports for Missouri are available for inspection at the Missouri District office, and may be purchased from:

Open-File Services Section  
U.S. Geological Survey  
Box 25425, Federal Center  
Denver, Colorado 80225

Map information:

To order maps write:

U.S. Geological Survey  
Map Distribution  
Federal Center, Bldg. 810  
Box 25286  
Denver, Colorado 80225

For additional information write:

National Cartographic Information Center  
Mid-Continent Mapping Center  
1400 Independence Road  
Mail Stop 231  
Rolla, Missouri 65401

General information:

Public Inquiries Offices (PIOs) provide general information about the programs of the U.S. Geological Survey and its reports and maps. The PIOs answer inquiries made in person, by mail, or by telephone and refer requests for specific technical information to the appropriate people. Direct inquiries for Missouri to:

Public Inquiries Office  
U.S. Geological Survey  
1028 General Services Administration Building  
19th and F Streets, NW  
Washington, D.C. 20244



#### REFERENCES CITED

- Harris, Barbara, 1979, Water in Missouri: Rolla, Missouri Division of Geology and Land Survey Educational Series 5, 28 p.
- Inman, E.J., 1986, Simulation of flood hydrographs for Georgia streams: U.S. Geological Survey Water-Resources Investigations Report 86-4004, 41 p.
- Missouri Division of Geology and Land Survey, 1967, Water resources, in Mineral and Water Resources of Missouri: Rolla, Missouri Division of Geology and Land Survey, ser. 2, v. 43, p. 254.
- National Weather Service, 1976, Climatological data, Missouri: Asheville, N.C., Department of Commerce, National Oceanic and Atmospheric Administration.
- Stricker, V.A., and Sauer, V.B., 1982, Techniques for estimating flood hydrographs for ungaged urban watersheds: U.S. Geological Survey Open-File Report 82-365, 24 p.

## SELECTED REFERENCES FOR MISSOURI

(Contact the Missouri District office for information regarding the availability of these publications)

- Alexander, T.W., in press, Delineation of flooding within the Ozark National Scenic Riverways in southeastern Missouri--Akers and Alley Spring: U.S. Geological Survey Hydrologic Investigations Atlas HA 712-A, 3 sheets.
- \_\_\_\_\_ in press, Delineation of flooding within the Ozark National Scenic Riverways in southeastern Missouri--Round Spring and Powder Mill: U.S. Geological Survey Hydrologic Investigations Atlas HA 712-B, 3 sheets.
- Barks, J. H., 1976, Water-quality characteristics of six small lakes in Missouri: Rolla, Missouri Division of Geology and Land Survey Water-Resources Report 33, 42 p.
- \_\_\_\_\_ 1977, Effects of abandoned lead and zinc mines and tailing piles on water quality in the Joplin area, Missouri: U.S. Geological Survey Water-Resources Investigations Report 77-75, 49 p.
- \_\_\_\_\_ 1978, Water quality in the Ozark National Scenic Riverways: U.S. Geological Survey Water-Supply Paper 2048, 57 p.
- Barks, J.H., and Berkas, W.R., 1979, Water quality in the proposed Prosperity Reservoir area, Center Creek basin, Missouri: U.S. Geological Survey Water-Resources Investigations Report 79-22, 26 p.
- Barks, J.H., Mesko, T.O., Bohm, R.A., Meier, D.H., and Williams, J.H., 1983, Geology, water movement, and sediment characteristics of the Spring River upstream from La Russell, southwestern Missouri: Rolla, Missouri Division of Geology and Land Survey Open-File Report 83-21-WR, 33 p.
- Becker, L.D., 1985, How the U.S. Geological Survey provides flood-estimating methods and conducts flood measurements [abs]: Jefferson City, Mo., Proceedings of the 1985 Stormwater Conference, p. 4-5.
- \_\_\_\_\_ 1986, Techniques for estimating flood-peak discharges from urban basins in Missouri: U.S. Geological Survey Water-Resources Investigations Report 86-4322, 38 p.
- Becker, L.D., Alexander, T.W., and Waite, L.A., 1983, Floods in Kansas City, Missouri, and vicinity, August 12-13, 1982: U.S. Geological Survey Water-Resources Investigations Report 83-4141, 35 p.
- Berkas, W.R., 1980, Effects of urban runoff and wastewater effluent on Wilsons Creek and James River near Springfield, Missouri: U.S. Geological Survey Water-Resources Investigations Report 80-27, 31 p.
- \_\_\_\_\_ 1982, Streamflow and water-quality conditions, Wilsons Creek and James River, Springfield area, Missouri: U.S. Geological Survey Water-Resources Investigations Report 82-26, 38 p.
- \_\_\_\_\_ 1983, Suspended-sediment data in the Salt River basin, Missouri: U.S. Geological Survey Open-File Report 83-275, 38 p.

SELECTED REFERENCES FOR MISSOURI--Continued

- Berkas, W.R., 1987, Traveltime, reaeration, and water-quality characteristics during low-flow conditions in Wilsons Creek and the James River near Springfield, Missouri: U.S. Geological Survey Water-Resources Investigations Report 87-4074, 32 p.
- \_\_\_\_\_, 1987, Water-quality assessment of Peruque Creek, St. Charles County, Missouri, July 1983 and July 1984: U.S. Geological Survey Water-Resources Investigations Report 87-4079, 45 p.
- Berkas, W.R., and Barks, J.H., 1980, Effects of the proposed Prosperity Reservoir on ground water in lower Center Creek basin, Missouri: U.S. Geological Survey Water-Resources Investigations Report 80-88, 29 p.
- Berkas, W.R., Femmer, S.V., Mesko, T.O., and Thompson, B.W., 1987, Surface-water hydrology of the Little Black River basin, Missouri and Arkansas, before water-land improvement practices: U.S. Geological Survey Water-Resources Investigations Report 87-4076, 54 p.
- Berkas, W.R., and Lodderhose, J.R., 1985, Water-quality assessment and wastewater-management alternatives for Dardenne Creek in St. Charles County, Missouri: U.S. Geological Survey Water-Resources Investigations Report 85-4120, 51 p.
- Bevans, H.E., Skelton, John, Kenny, J.F., and Davis, J.V., 1984, Hydrology of Area 39, Western Region, Interior Coal Province, Kansas and Missouri: U.S. Geological Survey, Water-Resources Investigations Open-File Report 83-851, 83 p.
- Blevins, D.W., 1985, Quality of stormwater runoff in the Blue River basin, Missouri and Kansas, July-October 1981 and April-July 1982: U.S. Geological Survey Water-Resources Investigations Report 84-4226, 131 p.
- \_\_\_\_\_, 1986, Sources of coal-mine drainage and their effects on surface-water chemistry in the Claybank Creek basin and vicinity, north-central Missouri, 1983-84: U.S. Geological Survey Open-File Report 85-571, 74 p., 3 pl.
- Bowie, J.E., 1971, Temperature of Missouri streams: U.S. Geological Survey, 350 p.
- Bowie, J.E., and Gann, E.E., 1967, Floods of July 18-23, 1965, in northwestern Missouri: Rolla, Missouri Division of Geology and Land Survey Water-Resources Report 21, 103 p.
- Bowie, J.E., and Petri, L.R., 1969, Travel of solutes in the lower Missouri River: U.S. Geological Survey Hydrologic Investigations Atlas HA-332, 1 sheet.
- Brahana, J.V., and Mesko, T.O., in press, Hydrogeology and preliminary assessment of regional flow in the upper Cretaceous and adjacent aquifers in the northern Mississippi embayment: U.S. Geological Survey Water-Resources Investigations Report 87-4000.

# SELECTED REFERENCES FOR MISSOURI--Continued

- Brahana, J.V., Mesko, T.O., Busby, J.F., and Kraemer, T.F., 1985, Ground-water quality data from the northern Mississippi embayment--Arkansas, Missouri, Kentucky, Tennessee, and Mississippi: U.S. Geological Survey Open-File Report 85-683, 15 p.
- Chin, E.H., Skelton, John, and Guy, H.P., 1975, The 1973 Mississippi River basin flood--Compilation and analysis of meteorologic, streamflow, and sediment data: U.S. Geological Survey Professional Paper 937, 137 p.
- Dean, T.J., Barks, J.H., and Williams, J.H., 1976, Guide for the geologic and hydrologic evaluation of small lake sites in Missouri: Rolla, Missouri Division of Geology and Land Survey Water-Resources Report 31, 50 p.
- Detroy, M.G., Skelton, John, and others, 1983, Hydrology of Area 38, Western Region, Interior Coal Province, Iowa and Missouri: U.S. Geological Survey Water-Resources Investigations Open-File Report 82-1014, 85 p.
- Emmett, L.F., and Imes, J.L., 1984, Ground-water resources of Audrain County, Missouri: U.S. Geological Survey Open-File Report 84-245, 55 p.
- Emmett, L.F., and Jeffery, H.G., 1968, Reconnaissance of the ground-water resources of the Missouri River alluvium between St. Charles and Jefferson City, Missouri: U.S. Geological Survey Hydrologic Investigations Atlas HA-315, 1 sheet.
- \_\_\_\_\_, 1969a, Reconnaissance of the ground-water resources of the Missouri River alluvium between Kansas City, Missouri, and the Iowa border: U.S. Geological Survey Hydrologic Investigations Atlas HA-336, 1 sheet.
- \_\_\_\_\_, 1969b, Reconnaissance of the ground-water resources of the Missouri River alluvium between Jefferson City and Miami, Missouri: U.S. Geological Survey Hydrologic Investigations Atlas HA-340, 1 sheet.
- \_\_\_\_\_, 1970, Reconnaissance of the ground-water resources of the Missouri River alluvium between Miami and Kansas City, Missouri: U.S. Geological Survey Hydrologic Investigations Atlas HA-344, 1 sheet.
- Emmett, L.F., Skelton, John, Luckey, R.R., and Miller, D.E., 1978, Water resources of the Springfield area, Missouri: Rolla, Missouri Division of Geology and Land Survey Water-Resources Report 34, 150 p.
- Feder, G.L., Skelton, John, Jeffery, H.G., and Harvey, E.J., 1969, Water resources of the Joplin area, Missouri: Rolla, Missouri Division of Geology and Land Survey Water-Resources Report 24, 97 p.
- Gann, E.E., 1971, Generalized flood-frequency estimates for urban areas in Missouri: U.S. Geological Survey Open-File report, 18 p.
- Gann, E.E., Harvey, E.J., Barks, J.H., and Fuller, D.L., 1973, Water resources of northwestern Missouri: U.S. Geological Survey Hydrologic Investigations Atlas HA-444, 4 sheets.

SELECTED REFERENCES FOR MISSOURI--Continued

- Gann, E.E., Harvey, E.J., Barks, J.H., Fuller, D.L., and Miller, D.E., 1974, Water resources of west-central Missouri: U.S. Geological Survey Hydrologic Investigations Atlas HA-491, 4 sheets.
- Gann, E.E., Harvey, E.J., Jeffery, H.G., and Fuller, D.L., 1971, Water resources of northeastern Missouri: U.S. Geological Survey Hydrologic Investigations Atlas HA-372, 4 sheets.
- Gann, E.E., Harvey, E.J., and Miller, D.E., 1976, Water resources of south-central Missouri: U.S. Geological Survey Hydrologic Investigations Atlas HA-550, 4 sheets.
- Hall, D.C., 1986, A description of the hydrologic system and the effects of coal mining on water quality in the East Fork Little Chariton River and the alluvial aquifer between Macon and Huntsville, north-central Missouri: U.S. Geological Survey Water-Resources Investigations Report 86-4160, 66 p.
- \_\_\_\_\_, 1987, Hydrogeochemical data of coal strip-mine spoil near Macon in north-central Missouri: U.S. Geological Survey Open-File Report 87-119, 18 p. Hall, D.C., and Berkas, W.R., in press, Comparison of instream and laboratory methods of measuring sediment oxygen demand: Water-Resources Bulletin.
- Hall, D.C., and Davis, R.E., 1986, Ground-water movement and effects of coal strip mining on water quality of high-wall lakes and aquifers in the Macon-Huntsville area, north-central Missouri: U.S. Geological Survey Water-Resources Investigations Report 85-4102, 102 p.
- Hall, D.C., and Steelman, S.H., in press, Missouri water supply and demand, in National Water Summary 1987--Selected hydrologic events and water supply and demand: U.S. Geological Survey Water-Supply Paper 2350.
- Harvey, E.J., 1980, Ground water in the Springfield-Salem Plateaus of southern Missouri and northern Arkansas: U.S. Geological Survey Water-Resources Investigations Report 80-101, 66 p.
- Harvey, E.J., and Emmett, L.F., 1980, Hydrology and model study of the proposed Prosperity Reservoir, Center Creek basin, Missouri: U.S. Geological Survey Water-Resources Investigations Report 80-7, 50 p.
- Harvey, E.J., Skelton, John, and Miller, D.E., 1983, Hydrology of carbonate terrane--the Niangua, Osage Fork, and Grandglaize Creek basins, Missouri: Rolla, Missouri Division of Geology and Land Survey Water-Resources Report 35, 132 p.
- Harvey, E.J., Williams, J.H., and Dinkel, T.R., 1977, Application of thermal imagery and aerial photography to hydrologic studies of karst terrane in Missouri: U.S. Geological Survey Water-Resources Investigations Report 77-16, 58 p.

SELECTED REFERENCES FOR MISSOURI--Continued

- Hauth, L.D., 1973a, Rainfall-runoff data for small drainage areas of Missouri: U.S. Geological Survey Open-File Report, 171 p.
- \_\_\_\_\_ 1973b, Selected storm events in 5-minute increments, from Missouri rainfall stations at Kansas City, St. Louis, Springfield, and Columbia: U.S. Geological Survey Open-File Report, 191 p.
- \_\_\_\_\_ 1974a, Technique for estimating the magnitude and frequency of Missouri floods: U.S. Geological Survey Open-File Report, 19 p.
- \_\_\_\_\_ 1974b, Model synthesis in frequency analysis of Missouri floods: U.S. Geological Survey Circular 708, 16 p.
- \_\_\_\_\_ 1980, Evaluation of peak-flow data network of small streams in Missouri: U.S. Geological Survey Water-Resources Investigations Report 80-87, 38 p.
- \_\_\_\_\_ 1982, Flow-duration data for Missouri streams: U.S. Geological Survey Open-File Report 81-1189, 26 p.
- Hauth, L.D., and Carswell, W.J., Jr., 1978, Floods in Kansas City, Missouri, and Kansas, September 12-13, 1977: U.S. Geological Survey Water-Resources Investigations Report 78-63, 36 p.
- Hauth, L.D., Carswell, W.J., Jr., and Chin, E.H., 1981, Floods in Kansas City, Missouri and Kansas, September 12-13, 1977: U.S. Geological Survey Professional Paper 1169, 47 p.
- Hauth, L.D., and Spencer, D.W., 1969, Floods in Gravois Creek basin, St. Louis County, Missouri: U.S. Geological Survey Open-File Report, 14 p.
- \_\_\_\_\_ 1971, Floods in Coldwater Creek, Watkins Creek, and River des Peres basins, St. Louis County, Missouri: U.S. Geological Survey Open-File Report, 36 p.
- Hedman, E.R., Skelton, John, and Freiwald, D.A., 1987, Flow characteristics for selected springs and streams in the Ozark subregion, Arkansas, Kansas, Missouri, and Oklahoma: U.S. Geological Survey Hydrologic Investigations Atlas HA-688, 4 sheets.
- Imes, J.L., 1985, The ground-water flow system in northern Missouri with emphasis on the Cambrian-Ordovician aquifer: U.S. Geological Survey Professional Paper 1305, 61 p.
- \_\_\_\_\_ in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-A, 1 sheet.
- \_\_\_\_\_ in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma--Basement confining unit: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-B, 1 sheet.

SELECTED REFERENCES FOR MISSOURI--Continued

- Imes, J.L., in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma--St. Francois aquifer: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-C, 2 sheets.
- \_\_\_\_\_ in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma--St. Francois confining layer: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-D, 3 sheets.
- \_\_\_\_\_ in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma--Ozark aquifer: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-E, 3 sheets.
- \_\_\_\_\_ in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma--Ozark confining layer: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-F, 3 sheets.
- \_\_\_\_\_ in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma--Springfield Plateau aquifer: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-G, 3 sheets.
- \_\_\_\_\_ in press, Major geohydrologic units in and adjacent to the Ozark Plateaus province, Missouri, Arkansas, Kansas, and Oklahoma--Western Interior Plains confining system: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-H, 3 sheets.
- Imes, J.L., and Davis, J.V., in press, Water type and concentration of dissolved solids, chloride, and sulfate in ground water from the St. Francois aquifer in Missouri: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-J, 1 sheet.
- \_\_\_\_\_ in press, Water type and concentration of dissolved solids, chloride, and sulfate in ground water from the Ozark aquifer in Missouri, Arkansas, Kansas, and Oklahoma: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-K, 4 sheets.
- \_\_\_\_\_ in press, Water type and concentration of dissolved solids, chloride, and sulfate in ground water from the Springfield Plateau aquifer in Missouri, Arkansas, Kansas, and Oklahoma: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-L, 2 sheets.
- Imes, J.L., and Smith, B.J., in press, Areal extent, stratigraphic relation, and geohydrologic properties of regional geohydrologic units in southern Missouri: U.S. Geological Survey Hydrologic Investigations Atlas HA-711-I, 3 sheets.
- Jorgensen, D.G., Helgesen, J.O., and Imes, J.L., in press, Regional aquifers in Kansas, Nebraska, and parts of Arkansas, Colorado, Missouri, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming--Geologic framework: U.S. Geological Survey Professional Paper 1414-B.

SELECTED REFERENCES FOR MISSOURI--Continued

- Kleeschulte, M.J., and Duley, J.W., 1985, Geology, water movement, and sediment characteristics of the Sugar, Romaine, and Rock Creek basins, with a section on Surficial material, by J.W. Whitfield: Rolla, Missouri Division of Geology and Land Survey Open-File Report 85-30-EG, 49 p.
- Kleeschulte, M.J., and Emmett, L.F., 1986, Compilation and preliminary interpretation of hydrologic data for the Weldon Spring radioactive waste-disposal sites, St. Charles County, Missouri--A progress report: U.S. Geological Survey Water-Resources Investigations Report 85-4272, 71 p.
- \_\_\_\_\_, 1986, Surface and ground-water interaction in the vicinity of a radioactive waste-disposal site, Weldon Spring Missouri [abs]: Midwest Ground Water Conference, 31st, Little Rock, Ark., 1986, Proceedings, p. 12-13.
- \_\_\_\_\_, 1987, Hydrology and water quality at the Weldon Spring radioactive waste-disposal sites, St. Charles County, Missouri: U.S. Geological Survey Water-Resources Investigations Report 87-4169, 65 p.
- Kleeschulte, M.J., Emmett, L.F., and Barks, J.H., 1986, Hydrologic data for the Weldon Spring radioactive waste-disposal sites, St. Charles County, Missouri--1984-1986: U.S. Geological Survey Open-File Report 86-488, 61 p.
- Kleeschulte, M.J., Mesko, T.O., and Vandike, J.E., 1985, Appraisal of the ground-water resources of Barton, Vernon, and Bates Counties, Missouri: Rolla, Missouri Division of Geology and Land Survey Water-Resources Report 36, 74 p.
- Kratzer, W.M., and Jenkins K.L. (compilers), 1985, Water-resources investigations of the U.S. Geological Survey in Missouri, fiscal year 1985: U.S. Geological Survey Open-File Report 95-188, 57 p.
- Luckey, R.R., 1985, Water resources of the southeast lowlands, Missouri, with a section on Water quality, by D.L. Fuller: U.S. Geological Survey Water-Resources Investigations Report 84-4277, 78 p.
- Luckey, R.R., and Fuller, D.L., 1980, Hydrogeologic data for the Mississippi embayment of southeastern Missouri: U.S. Geological Survey Open-File Report 79-421, 199 p.
- Marikos, Mark, and Skelton, John, 1982, Estimated water use in Missouri, 1980: Rolla, Missouri Division of Geology and Land Survey Open-File Map Report, 1 sheet.
- Maxwell, J.C., and Harvey, E.J., 1965, Use of abandoned mines as a potential water resource, Joplin district, Missouri [abs]: Mining Engineering, v. 17, no. 8, p. 51.
- Mesko, T.O., 1986, Geohydrology of the Tiger Mine area near Worland, Bates County, Missouri [abs]: Midwest Ground Water Conference, 31st, Little Rock, Ark., 1986, Proceedings, p. 14-15.



SELECTED REFERENCES FOR MISSOURI--Continued

- Mesko, T.O., in press, Subsurface geology of Paleozoic, Mesozoic, and Cenozoic units of southeast Missouri: U.S. Geological Survey Miscellaneous Investigations Series I-1875, 3 sheets.
- \_\_\_\_\_ in press, Geohydrology of a coal-mining area, southwestern Bates County, Missouri: U.S. Geological Survey Water-Resources Investigations Report 87-4204.
- Mesko, T.O., and Berkas, W.R., in press, Missouri ground-water quality, in National water summary 1986--Selected hydrologic events and ground-water quality: U.S. Geological Survey Water-Supply Paper 2325.
- Miller, D.E., Emmett, L.F., Skelton, John, Jeffery, H.G., and Barks, J.H., 1974, Water resources of the St. Louis area, Missouri: Rolla, Missouri Division of Geology and Land Survey Water-Resources Report 30, 114 p.
- Peterson, M.S., 1965, Floods of June 17th and 18th, 1964, in Jefferson, Ste. Genevieve, and St. Francois Counties, Missouri: Rolla, Missouri Division of Geology and Land Survey Water Resources Report 19, 20 p.
- Sandhous, E.H., and Skelton, John, 1968, Magnitude and frequency of Missouri floods: Rolla, Missouri Division of Geology and Land Survey Water-Resources Report 23, 276 p.
- Skelton, John, 1966, Low-flow characteristics of Missouri streams: Missouri Division of Geology and Land Survey Water-Resources Report 20, 95 p.
- \_\_\_\_\_ 1968, Storage requirements to augment low flows of Missouri streams: Rolla, Missouri Division of Geology and Land Survey Water-Resources Report 22, 78 p.
- \_\_\_\_\_ 1970, Base-flow recession characteristics and seasonal low-flow frequency characteristics for Missouri streams: Rolla, Missouri Division of Geology and Land Survey Water-Resources Report 25, 43 p.
- \_\_\_\_\_ 1971, Carryover storage requirements for reservoir design in Missouri: Rolla, Missouri Division of Geology and Land Survey Water-Resources Report 27, 56 p.
- \_\_\_\_\_ 1973, Flood-volume design data for Missouri streams: Rolla, Missouri Division of Geology and Land Survey Water-Resources Report 28, 28 p.
- \_\_\_\_\_ 1974, Estimating low-flow frequency for perennial Missouri Ozarks streams: U.S. Geological Survey Water-Resources Investigations Report 59-73, 19 p.
- \_\_\_\_\_ 1976, Missouri stream and springflow characteristics--Low-flow frequency and flow duration: Rolla, Missouri Division of Geology and Land Survey Water-Resources Report 32, 76 p.
- \_\_\_\_\_ 1977, Streamflow characteristics of the Joplin area, Missouri: U.S. Geological Survey Open-File Report 77-605, 32 p.

SELECTED REFERENCES FOR MISSOURI--Continued

- Skelton, John, Harvey, E.J., and Miller, D.E., 1982, Water information for northwestern Missouri--A planning document: U.S. Geological Survey Water-Resources Investigations Report 82-27, 58 p.
- Skelton, John, and Homyk, Anthony, 1970, A proposed streamflow data program for Missouri: U.S. Geological Survey Open-File Report, 44 p.
- Smith, B.J., in press, Assessment of water quality in non-coal mining areas of Missouri: U.S. Geological Survey Water-Resources Investigations Report 87-4286.
- Southard, R.E., 1986, An alternative basin characteristic for use in estimating impervious area in urban Missouri basins: U.S. Geological Survey Water-Resources Investigations Report 86-4362, 21 p.
- Spencer, D.W., 1971, Computed flood profile--River des Peres, Groby Street to 82nd Boulevard, University City, St. Louis County, Missouri: U.S. Geological Survey Open-File Report, 14 p.
- Spencer, D.W., and Alexander, T.W., 1978, Technique for estimating the magnitude and frequency of floods in St. Louis County, Missouri: U.S. Geological Survey Water-Resources Investigations Report 78-139, 23 p.
- Spencer, D.W., and Hauth, L.D., 1968, Floods in Maline Creek basin, St. Charles County, Missouri: U.S. Geological Survey Open-File Report, 12 p.
- U.S. Geological Survey, 1982, Water-resources investigations of the U.S. Geological Survey in Missouri: 1 sheet.
- U.S. Geological Survey, and Missouri Division of Geology and Land Survey, 1967, Mineral and water resources of Missouri: U.S. 90th Congress, 1st Session, Senate Document 19, 399 p.; also Missouri Geological Survey and Water Resources, v. XLIII, 2d ser., 399 p.
- Vaill, J.E., and Barks, J.H., 1980, Physical environment and hydrologic characteristics of coal-mining areas in Missouri: U.S. Geological Survey Water-Resources Investigations Report 80-67, 33 p.
- Vineyard, J.D., and Feder, G.L., 1974, Springs of Missouri: Rolla, Missouri Division of Geology and Land Survey Water-Resources Report 29, 266 p. (reprinted 1982).
- Waite, L.A., 1984, Data and funding of the stream-gaging program in Missouri: U.S. Geological Survey Open-File Report 84-868, 32 p.
- Waite, L.A., and Alexander, T.W., 1987, Floods of December 1982 in southeastern Missouri: U.S. Geological Survey Hydrologic Investigations Atlas HA-689, 1 sheet.
- Waite, L.A., Davis, J.V., Reed, H.L., Hatten, D.O., and Perkins, T.J., 1985, Water resources data, Missouri, water year 1984: U.S. Geological Survey Water-Data Report MO-84-1, 329 p. (published annually).

SELECTED REFERENCES FOR MISSOURI--Continued

Waite, L.A., Davis, J.V., Reed, H.L., Perkins, T.J., and Hatten, D.O., 1986, Water resources data, Missouri, water year 1985: U.S. Geological Survey Water-Data Report MO-85-1, 320 p. (published annually).

\_\_\_\_ 1987, Water resources data Missouri, water year 1986: U.S. Geological Survey Water-Data Report MO-86-1, 325 p. (published annually).

Williams, J.H., Vaughn, J.D., Price, P.T., and Chafin, Dan, 1986, Geology, hydrology, and pedology of six dioxin-contaminated sites in Missouri: Administrative Report prepared for the U.S. Environmental Protection Agency, 93 p.